

03588

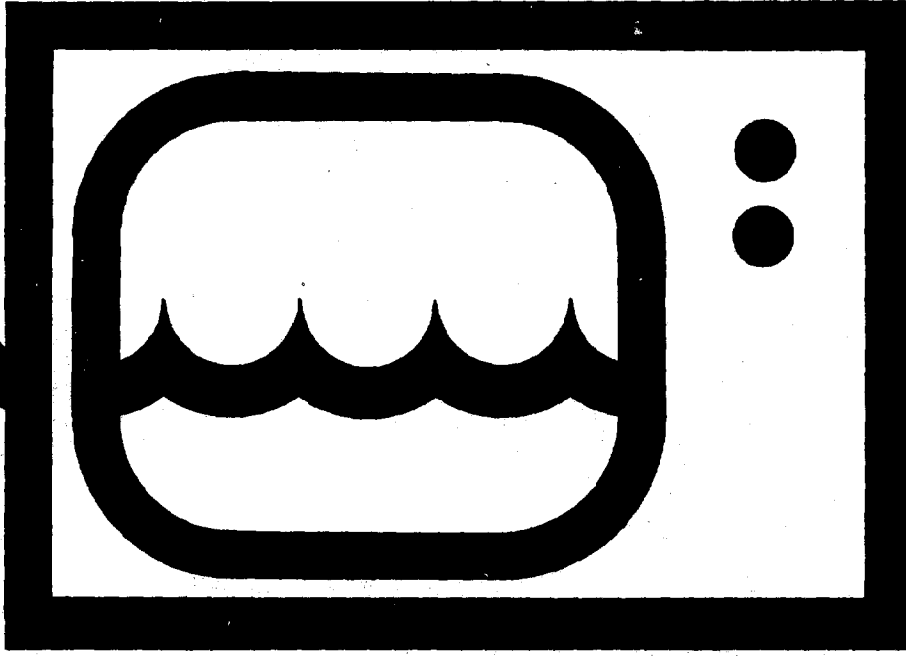
Coastal Zone
Information
Center

A GUIDE FOR TEACHERS AND STUDENTS

COASTAL ZONE
INFORMATION CENTER

New England & the Sea

JAN 24 1974



THAYER SHAFER, editor

GB
459.3
N29
1973



MARINE ADVISORY SERVICE

MARINE BULLETIN NUMBER 11
UNIVERSITY OF RHODE ISLAND

One Dollar

UNIVERSITY OF RHODE ISLAND

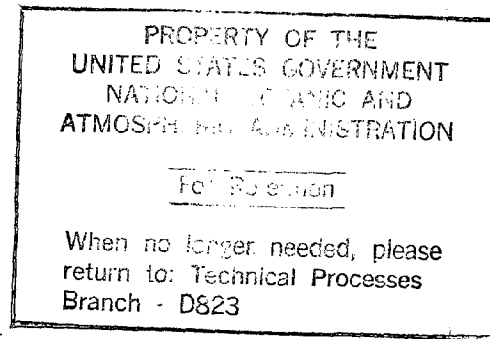
This publication and the TV series it accompanies were produced in cooperation with WTEV-Channel 6, New Bedford-Providence, and the Cooperative Extension Services of the Universities of Rhode Island and Massachusetts.

GB459.3 N29 1973

035,88

NEW ENGLAND AND THE SEA
a Guide for Students and Teachers

Thayer Shafer



University of Rhode Island
Marine Bulletin Series - No. 11
Kingston - 1972
2nd. edition - 1973

CONTENTS

2	Potpourri
5	Oceanography
10	Evolution of the New England Coast
15	Tide Pools and the Rocky Intertidal Zone
18	Beach, Dune and Marsh
22	Sounds of the Sea
26	Marine Food Chain
31	Cornucopia
35	Commercial Fishing
38	Boats
41	Navigation
45	Arts of the Sea
49	Pollution
54	Coastal Zone Uses
56	Marine Careers

INTRODUCTION

This guide to some major topics in marine education was written to accompany the showing of the television series, *New England and the Sea*, produced in the fall of 1972 for 4-H audiences in Rhode Island and Massachusetts by the University of Rhode Island Marine Advisory Service. Although New England was the setting for the series, the material can be used in any study of marine topics.

The group of Massachusetts secondary teachers who met in the summer of 1972 to write the guides set three aims: (1) give the teacher enough material so he or she is able to discuss important points of the TV series without references to other sources; (2) provide enough references to enable the teacher to build a unit on each aspect of the marine environment and (3) offer enough activities to enrich both individual and class study.

For the original drafts, thanks go to four Massachusetts teachers, Arthur Bedard, Canton High School; John Crowley, Hingham High School; Randolph Johnson, Lynnfield High School, and Harold Wiper, Newton High School; Mary Moore, New England Aquarium; Susan Anderson and Francine Jacoff, University of Rhode Island graduate students in marine affairs and education, respectively, and Neil Ross of the URI Marine Advisory Service. Through their efforts this guide emerged in the midst of the overall production of the series.

The booklet is meant to be used -- torn apart, copied, written in -- in any way necessary. And the teacher's guides with their illustrations, examples and major points are meant to be shared with students. We hope that in the classroom -- even though the TV series is completed -- this booklet will stimulate students and teachers to make a deeper study of the marine environment.

Feedback on the booklet is invited. Funds are being sought to revise and upgrade the television series. Please address suggestions to the Education Specialist, URI Marine Advisory Service, University of Rhode Island, Narragansett Bay Campus, Narragansett, Rhode Island 02882. Additional copies of the guide at \$1.00 each are available from the same address.

Thayer Shafer, MAS marine education
specialist

2.

POTPOURRI

FOR THE TEACHER

Major Points

1. The ocean covers 71 percent of the earth's surface.
2. It contains almost all the world's water (see table; make copies for the class).
3. Most of the world's major population centers are on harbors.
4. Seventy percent of the population of the United States lives in coastal states.
5. Seventy percent of the oxygen in the atmosphere is produced by the photosynthesis of phytoplankton.
6. Man uses the ocean for war, for its biological and mineral resources, for transportation and as a sewer.
7. The sea has played a very important role in shaping our history, music, art and literature.
8. Today, the sea has taken on a new role for Americans. Always enjoyed as a source of recreation by a few, in many areas its recreational value has become most important for many people.
9. There is no science of oceanography; oceanography is the application of all of man's science to the study of oceans.

Activities

1. Plan visits to marine museums, aquariums, historic seaports and art museums.
2. Plan field trips to an ocean beach (fall and spring), a rocky tide pool area, a salt marsh, a fishing port and a large harbor.
3. Start a marine library for your school. Try to obtain the references listed in the teacher's guides and student activities sheets.
4. Build a marine aquarium.

References

Films:

1. "The Restless Sea." Local Bell Telephone Office. 60 min., color.
Free on loan.

Books:

1. Oceanography - Readings from the Scientific American, by J. Robert Moore. 1971. W. H. Freeman and Company, San Francisco, Calif., 417 p. \$5.75.
2. Man and the Sea, by Bernard L. Gordon. 1970. The Natural History Press, Garden City, N.Y. \$9.95.
3. Exploring the Ocean World, by C.P. Idyll. 1969. Thomas Y. Crowell Company, New York, N.Y., 269 p. \$7.50.
4. 1001 Questions Answered About the Oceans and Oceanography, by Robert W. Taber and Harold W. Dubach. 1972. Dodd, Mead and Company, New York, N.Y. 269 p. \$7.50.

Subscribe to the National Fisherman, Camden, Maine 04843.

DISTRIBUTION OF WORLD'S ESTIMATED WATER SUPPLY

Location	Surface area (square miles)	Water volume (cubic miles)*	Percentage of total water
Freshwater lakes	330,000	30,000	.009
Saline lakes and inland seas	270,000	25,000	.008
Average in stream channels		300	.0001
Vadose water (includes soil moisture)		16,000	.005
Ground water within depth of half a mile	50,000,000	1,000,000	.31
Ground water - deep lying		1,000,000	.31
Icecaps and glaciers	6,900,000	7,000,000	2.15
Atmosphere (at sea level)	197,000,000	3,100	.001
World ocean	<u>139,500,000</u>	<u>317,000,000</u>	<u>97.2</u>
TOTALS (rounded)		326,000,000	100

*One cubic mile of water equals 1.1 trillion gallons.

Potpourri

FOR THE STUDENT

"New England and the Sea" is about the oceans and you.

Wherever you live your life is influenced by the oceans. The water you drink and the water you wash with started in the oceans and will return there. If there were no oceans, your planet would be intolerably hot during the day and intolerably cold at night. Seventy percent of our life-giving oxygen is produced by plants of the ocean surface waters. Much of the raw material used by industry and many of the goods you can buy in the stores were transported by ship. And you may be part of the great populations that live in coastal areas.

During colonial times the United States depended on goods brought from Europe, and during her first 100 years as a nation most of her wealth came from foreign trade. New England, more than any other portion of the country, has always been tied to the seas that lap its shores. Yankee ships and Yankee men have been known in all the ports of the world. Yankee trade has affected our entire culture as a nation, whether the goods involved were tea from China, slaves from Africa, cod from Georges Bank, whales from the Antarctic, gold from Alaska or guano from Chile.

"New England and the Sea" is not just a science program about the ocean. There is no single science of oceanography. Rather, oceanography is the application of all science to the study of the oceans. And this series is not just about oceanography, but rather an attempt to introduce you to all the ways in which man and the sea interact whether it be through history, art, music, literature, economics or the natural sciences.

Things to Do

1. Ask your librarian to help you find a book about the sea. It can be fiction or nonfiction.
2. Go to an art gallery and look at some of the paintings of the sea.
3. If you can, go to a marine museum. Much of the art related to the sea has been incorporated into the building of ships and, in fact, the building of ships was itself more art than engineering until very recently.
4. Go to a supermarket and try to find all the food products that come from the sea. During this series, see how many new ones you can add to your list.

OCEANOGRAPHY

FOR THE TEACHER

Major Points

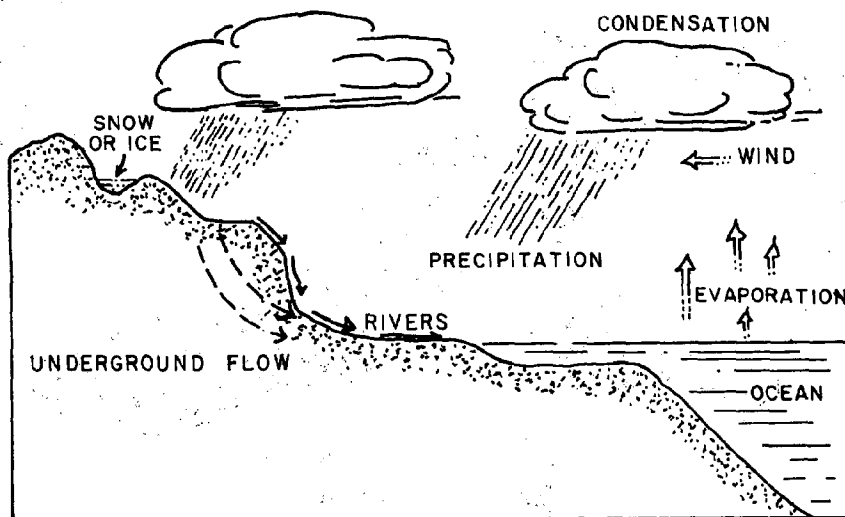
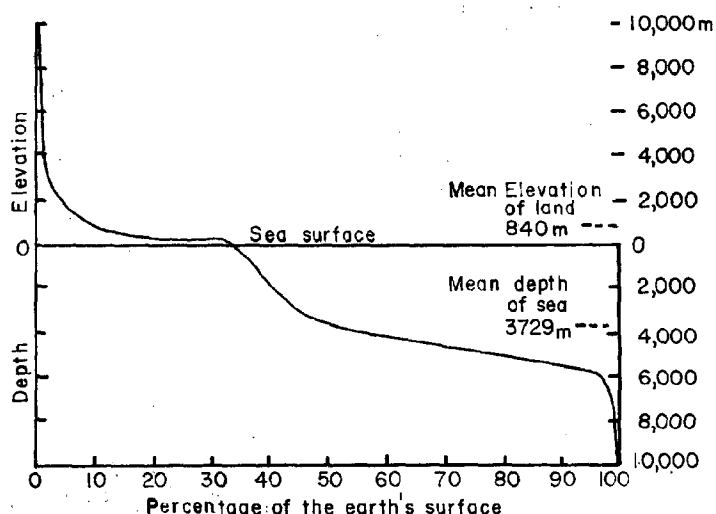
1. The ocean is a great reservoir of heat energy derived from the sun. The power of river waters originates as solar heat that evaporated water from the ocean. Our weather as well is powered by the ocean's thermal behavior.
2. The heat energy of the ocean powers its currents. The various living organisms of the sea derive their matter and energy from the sea. Tides, waves and deep water upwellings distribute these nutrients throughout the water environment.
3. Oceanography has had a long history in New England. Its shoreline, its industries and its people are wedded to the sea.

Activities

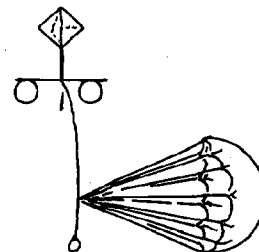
1. Construct drift card current meters to study local currents. Prepare a post card including return address as well as a request to finder for the date and point of collection. Laminate the post card with contact paper slightly weighted with sand at one end and with a piece of styrofoam at the other in order to maintain the card vertically at water surface. Students can then maintain a coastal chart, marking points of recovery as well as the dates. Current directions and rates may then be calculated. Contact your nearest Coast Guard unit to arrange for the release of drift cards or bottles.

The hypsographic curve (top) shows the percentage of the earth's surface above a given elevation or depth.

The hydrological cycle (below). For simplicity, biological utilization by plants and animals is not shown here.

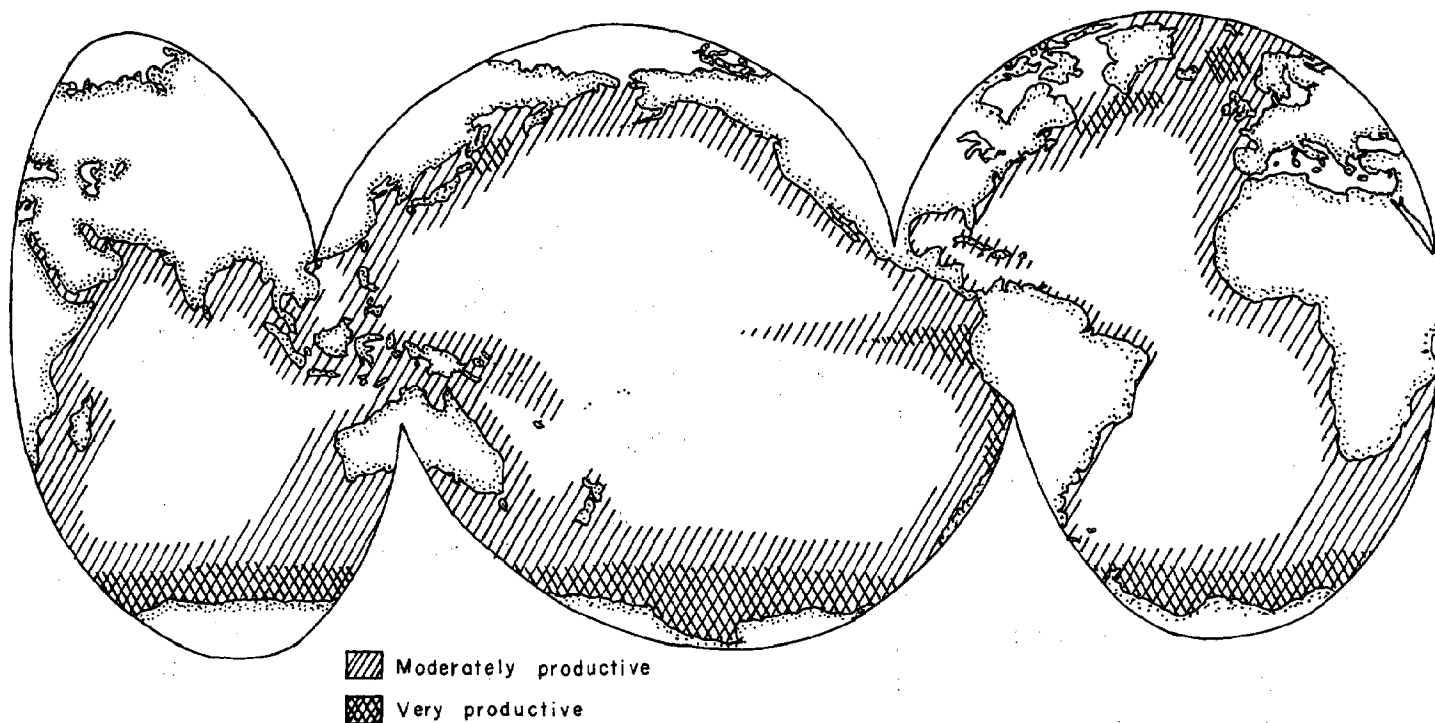
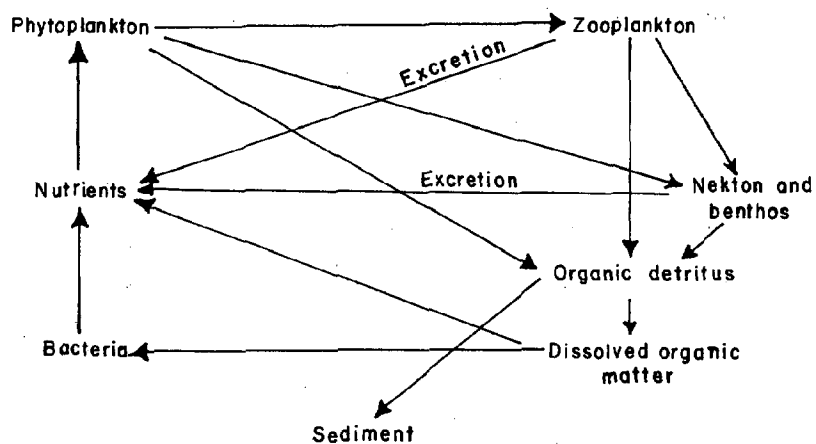


2. Attach a float to a cross made of sheet metal (see page 8) or to a weighted parachute. Release from a boat or bridge and use triangulation to follow its movement (page 44). In an estuary with a surface flow you can lengthen the wire suspending the cross or parachute to trace the movement of sub-surface currents.



(right) Diagrammatic representation of the cycle of life in the ocean.

(below) Schematic representation of the probable plant productivity of ocean areas.



References

Books:

1. Waves and Beaches, by Willard Bascom. 1964. Doubleday & Co., Garden City, N.Y. \$1.45.
2. This Great and Wide Sea, by R.D. Coker. 1947. Harper & Row, New York \$2.25.
3. The Open Sea: Its Natural History, by Alister Hardy. 1965. Houghton Mifflin Co., Boston, Mass. \$15.00.
4. A Guide to the Study of Freshwater Ecology, by William A. Andrews. 1972. Prentice-Hall, Inc., Englewood Cliffs, N.J. 182 pages, paper.

Charts:

1. Oceanography Chart. A colorful wall chart that includes charts, pictures, tables of information and glossary of terms. 38½" x 29½". \$3.50.
Roy G. Scarfo, Inc., P.O. Box 217, Thorndale, Pa. 19372. Tel. (215) 269-2552.
2. Marine Plankton Primer. A well-illustrated 10-page booklet accompanied by a large wall chart. Martek Instruments Inc., 879 W. 16th St., Newport Beach, Calif. 92660. \$1.00.

Films:

1. "Exploring the Ocean." Churchill Films, 662 North Robertson Blvd., Los Angeles, Calif. 90069. 16 mm., color, sound, 10 min.
2. "The Restless Sea." Local Bell Telephone Office. 16mm., color, sound, 1 hr.
3. "Science of the Sea." International Film Bureau, Inc., 332 S. Michigan Ave., Chicago, Ill. 60604. 16mm., color, sound, 19 min.
4. "Ocean Currents." McGraw-Hill text film, Krasker Memorial Film Library, Boston University School of Education, 765 Commonwealth Ave., Boston Mass. 02215.
16 mm., color, 16 min.

Oceanography

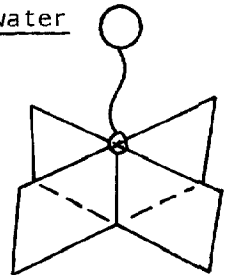
FOR THE STUDENT

If you are interested in reading about the oceans and some of the interesting things that are currently going on, you may wish to receive Sea Frontiers/Sea Secrets, the publications of the International Oceanographic Foundation, 10 Rickenbacker Causeway, Virginia Key, Miami, Fla. 33149. These publications are non-technical and beautifully illustrated. Perhaps your school library, local library, or your class might wish to subscribe to them.

You or your class may wish to study a local pond, stream, or estuary. Your library may have references, but a good one is A Guide to the Study of Freshwater Ecology, William A. Andrews, ed. 1972. Prentice-Hall, Inc., Englewood, N.J.

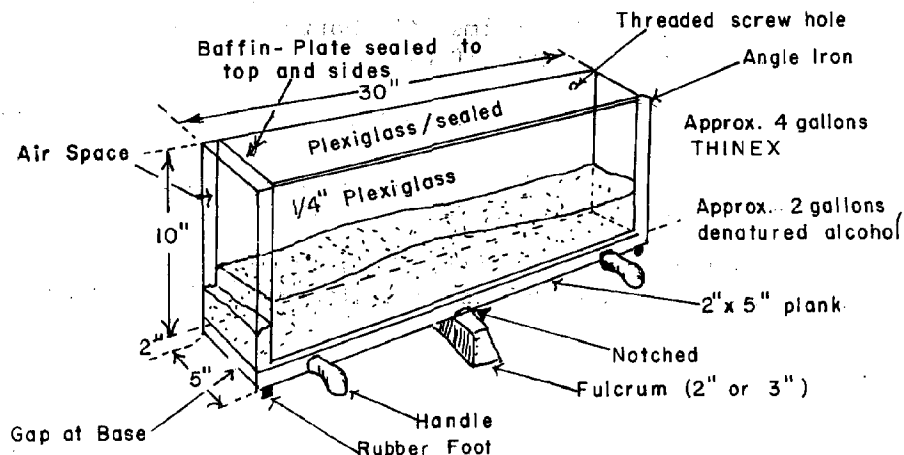
If you live near an estuary, you can study tidal flow by making a current buoy. Use a styrofoam toilet float (any piece of styrofoam will work, but a toilet float has a metal fitting to which you can attach things). Make a cross out of light sheet metal and hang it under the float by a stiff wire.

CURRENT BUOY



You can put another piece of wire out the top of the float with a little flag on it. Follow its movement. By varying the length of the suspension wire you can check movement at different depths. If you and a friend work together you can map the float movements by triangulation. Correlate this with the tide tables.

If you don't live near the ocean, perhaps you would like to make a wave machine. This will enable you to produce waves in slow motion. Please read carefully note about the dangers involved in constructing this machine.



The diagram is suitable to follow for construction by the amateur scientist. Instead of a cumbersome external expansion tank, we suggest simply allowing an air space at the top, equal to about 10 percent of the total volume. Another idea might be to warm the liquids before sealing the tank to a temperature slightly above the highest room temperature expected. In any case take extreme care against possible breakage or fire following breakage. The tank is constructed with Lexan Plexiglass, using plexi-solvent to bond the sides together. You could make one from a glass bottle or jug.

The slow-motion effect of the waves is achieved by the use of two non-mixing liquids, one just slightly heavier (more dense) than the other. Since the liquids are almost identical in density, only very slowly can the heavier one displace the lighter one. As much flow resistance occurs at the interface, waves are cast up and slowly fall to rejoin the heavier liquid.

The liquids we use are a paint thinner called THINEX (clear) and denatured alcohol dyed blue (add small quantity of food coloring). Both are highly inflammable and extreme care must be taken. Other liquids similar in density could be substituted; experiment. Two safe ones are mineral oil and water. Dissolve the food coloring in the water.

The iron frame might be dispensed with if tests reveal very strong bonding. Plate glass and epoxy cement may be used in place of the Plexiglass which will slowly soften over a period of two to three years.

Reference:

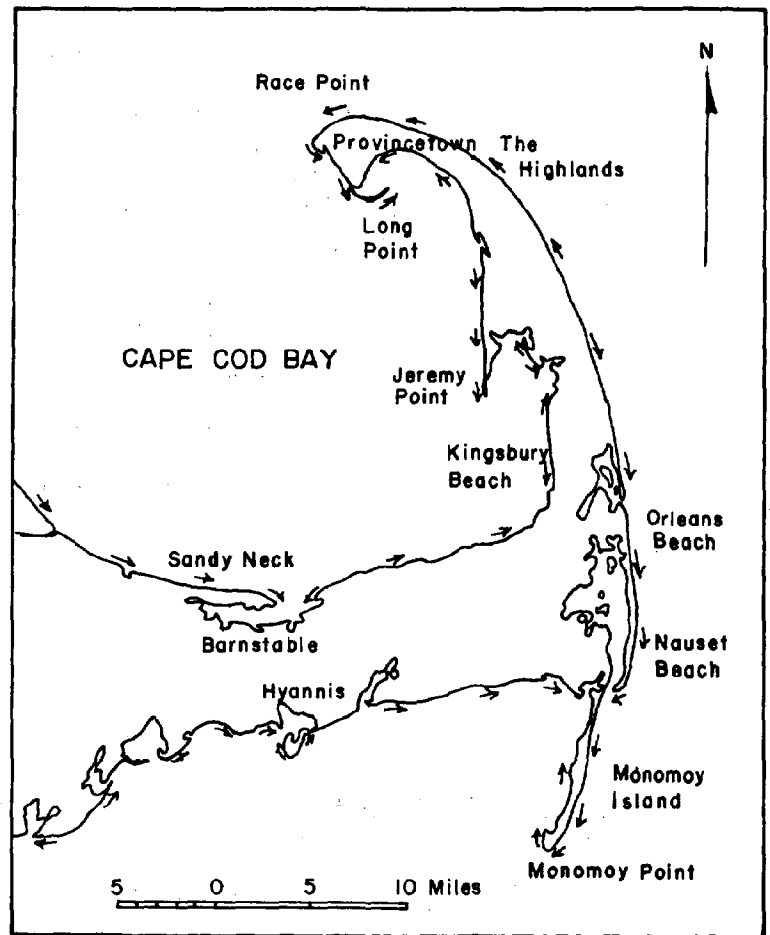
1. This Great and Wide Sea. R.D. Coker, 1947. Harper and Row, New York, N.Y., \$2.25.
2. Under The Sea Wind, Rachel Carson.

EVOLUTION OF THE NEW ENGLAND COAST

FOR THE TEACHER

Major Points

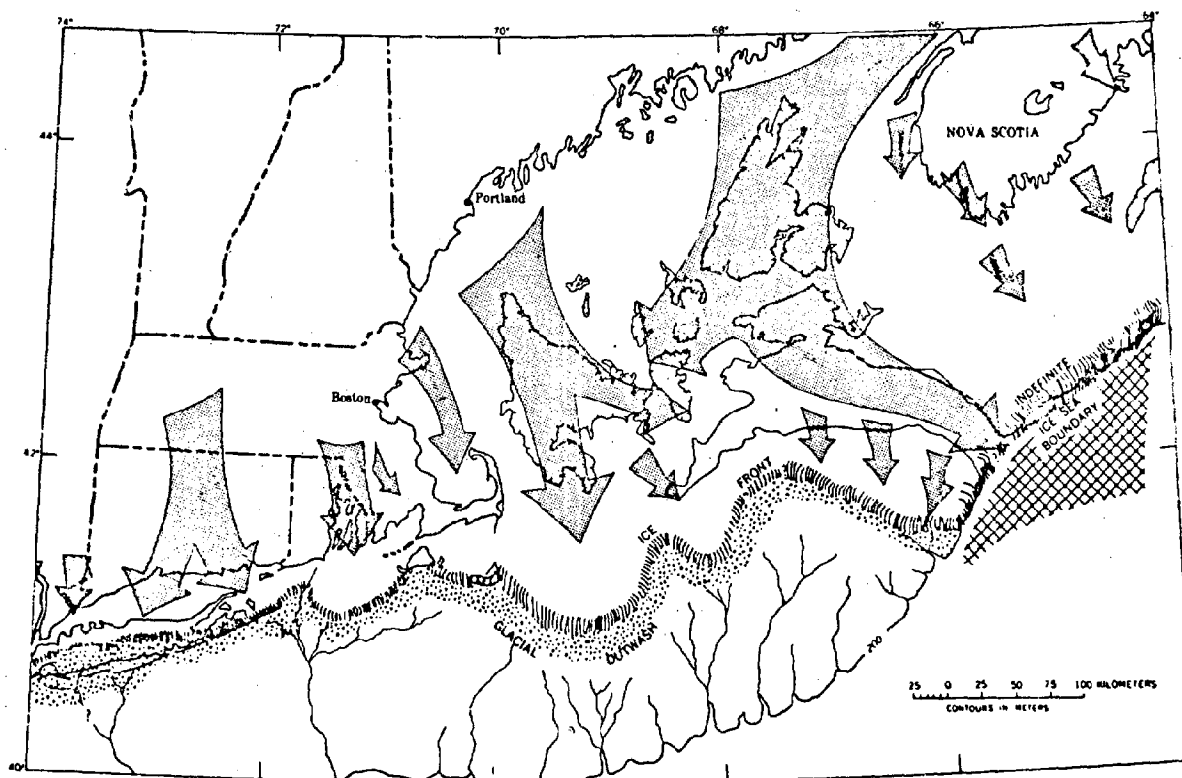
1. The granite common to New England is indicative of the igneous volcanic origins of much of the rocky New England substrate, particularly the young jagged coast from Boston to Maine. Note that this must have been a very active area in the prehistoric past.
2. The combination of glaciers with an emerging coastline north of Boston and a submergent coast to the south have formed the major geological features of New England, i.e., the large continental shelf, Cape Cod and the rocky coast of Maine.
3. Wind, waves and long shore currents combine to build up or destroy coastal features such as barrier beaches, sand spits, mud flats and marshes. For example, the erosion of Nauset Beach provides material for the build up of Monomoy Island.
4. Nothing along our coastline is permanent. The earth's crust may rise or fall slowly or rapidly due to glacial weight or internal pressure. Sea level changes as glaciers grow or melt. The forces of wind and waves are constantly changing and reshaping the coastline in a never ending battle between land and sea.



Activities

1. Build a stream table to show various pattern in the movement of sand and water.
2. Make a ripple tank with models of various bays, harbors and breakwaters. Try to predict the areas of high wave energy (convergent waves) and low energy (divergent). (See guide for the student).

3. Do topographic map work, trace contour lines and locate drumlins and terminal moraines from Cape Cod through Nantucket to Martha's Vineyard, Block Island and Long Island.
4. Build a three-dimensional contour model from a marine chart of your local area or our North Atlantic coastline.



Schematic diagram of maximum glacial advance off the northeastern U.S. Arrows show major currents of movement of the ice sheet.

References

1. The Atlantic Shore, by John Hay and Peter Farb. 1966. Harper & Row New York, N.Y. \$6.00.
2. A Geologist's View of Cape Cod, by Arthur M. Straphler. 1966. Natural History Press, Garden City, N.Y. \$1.95.
3. The Outermost House, by Henry Beston. 1962. Viking Press. \$1.45.
4. These Fragil Outposts - A Geological Look at Cape Cod, Marthas Vineyard, and Nantucket, by Barbara Chamberlain. 1964. Natural History Press. Garden City, N.Y. 327 Pages.

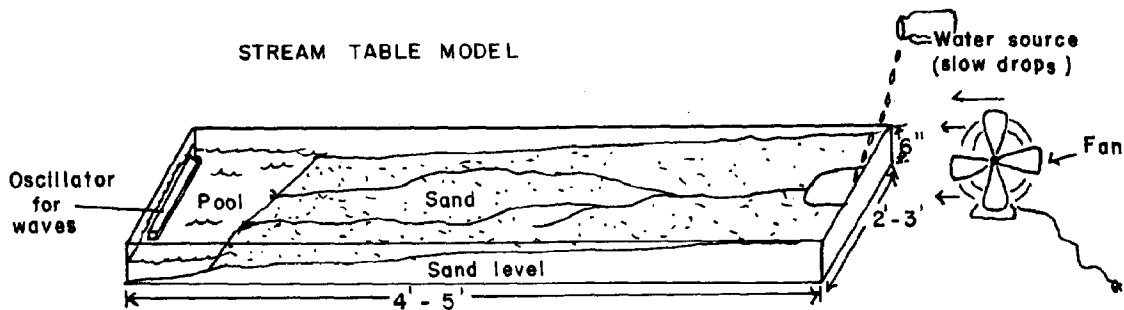
Films

1. "The Beach, The River of Sand," E.B.F. (16 mm, 20 min.) 425 North Michigan Avenue, Chicago, IL. 60611.
2. "The Earth Beneath the Sea," (16 mm, 27 min.-color). McGraw Hill Pub. Company, 330 West 42nd Street, New York, N.Y. 10036.
3. "History Layer by Layer," (16 mm. 23 min.-color). McGraw Hill Pub. Company, 330 West 42nd Street, New York, N.Y. 10036.

Evolution of the New England Coast

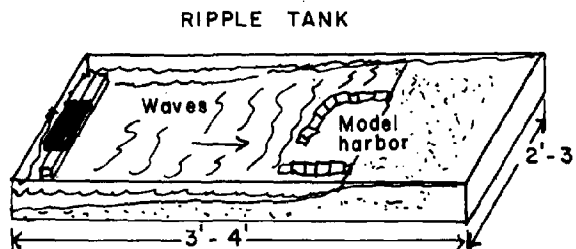
FOR THE STUDENT

Our coastline is not fixed, but is constantly undergoing change. Some changes are quite evident -- a hurricane or winter storm destroys a breakwater or rips out a 30-40 foot piece of cliff on the outer Cape. Other changes are more subtle like the slow movement of sand bars or changes in the channel in a harbor, which result in a need for dredging every five or ten years. To help understand the relationship between wind, sand and waves it will be helpful to make a stream table or a ripple tank. Place a large cardboard box around the end of the tank opposite the fan to catch flying sand.

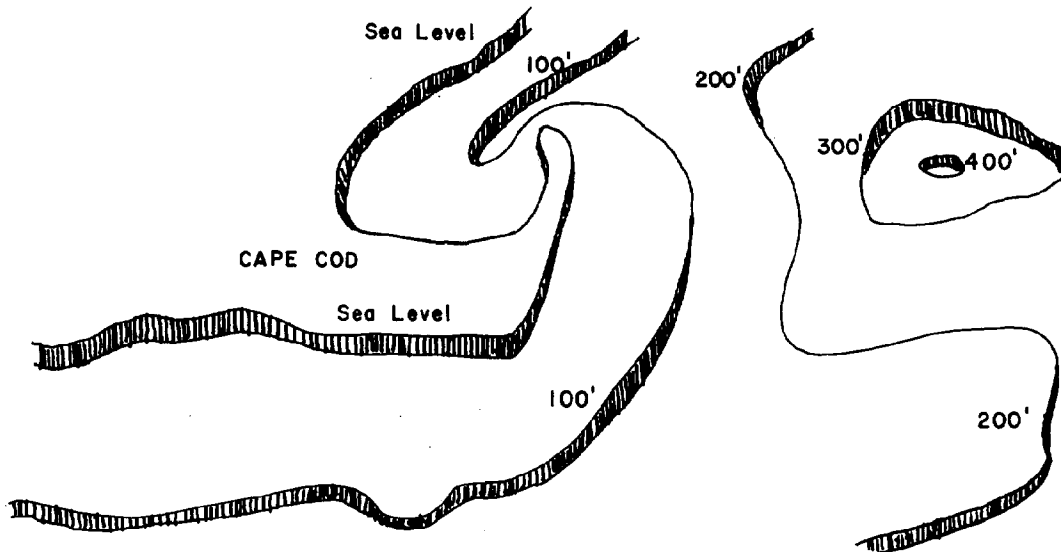


Fill table with fine sand and grade to fit various lab activities. Table can be used to show effects of erosion or build up and movement of sand dunes (using the fan) or as a wave tank by putting a moveable bar in the pool area.

Build a ripple tank. Obtain a shallow tray and a long flat log. Fill the tray with 1 to 2 inches of water, place the log at one end, and cause it to wobble at various frequencies to give different wave patterns. Harbors and breakwaters of various shapes can be placed in front of the waves to change their behavior. (Note the stream table tank can be used as a ripple tank and vice versa.)



To get an in-depth view of our coastline, build a three-dimensional contour model. To do this get a local marine chart or even better chart #70, United States Coast and Geodetic Survey (now National Ocean Survey), "West Quoddy Head to New York," (\$1.50) from Long Island to Nova Scotia. Cut out along the shoreline and trace this onto a piece of 1/4-inch cardboard or 1/2-inch homosote. Select a proper depth interval (30 feet for local charts or 100 feet for offshore charts) and cut along these contour lines. Stack and glue the layers, in the same relationship they are found on the chart. When you have finished you should have a "wedding cake" effect with the land on the top layer and deepest points at the bottom. The contour interval on the chart may change as you go further offshore. Use additional thicknesses of material to maintain a uniform scale. You may wish to use plaster to smooth the inside surface of your model. This model can be coated with water repellent and filled with water to act as a three-dimensional wave tank or for other classroom demonstrations.



TIDE POOLS AND THE ROCKY INTERTIDAL ZONE

FOR THE TEACHER

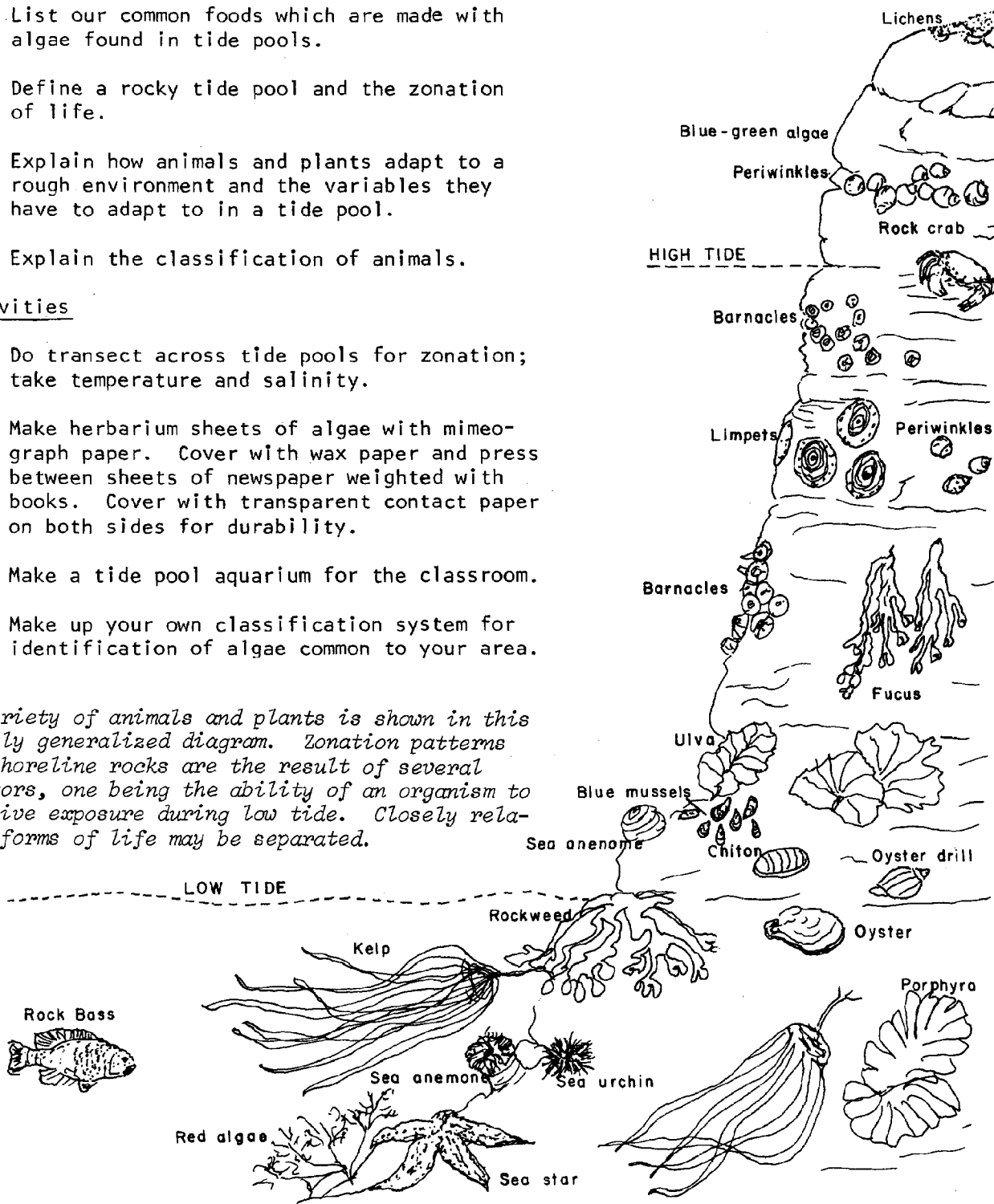
Major Points

1. List our common foods which are made with algae found in tide pools.
2. Define a rocky tide pool and the zonation of life.
3. Explain how animals and plants adapt to a rough environment and the variables they have to adapt to in a tide pool.
4. Explain the classification of animals.

Activities

1. Do transect across tide pools for zonation; take temperature and salinity.
2. Make herbarium sheets of algae with mimeograph paper. Cover with wax paper and press between sheets of newspaper weighted with books. Cover with transparent contact paper on both sides for durability.
3. Make a tide pool aquarium for the classroom.
4. Make up your own classification system for identification of algae common to your area.

A variety of animals and plants is shown in this highly generalized diagram. Zonation patterns on shoreline rocks are the result of several factors, one being the ability of an organism to survive exposure during low tide. Closely related forms of life may be separated.



References

Books:

1. Seashores, by Herbert Zim and Lester Ingle. 1955. Golden Press, Western Publishing Co., Racine, Wi. 160 p. \$3.95, paper \$1.00.
2. The Life of the Seashore, by William H. Amos. 1966. McGraw Hill Book Co., New York, N.Y. 231 p. \$4.95.
3. Edge of the Sea, by Rachel L. Carson. 1955. Houghton Mifflin Co., Boston, Ma. 276 p. \$5.95.

Films:

1. "Between the Tides." Contemporary Films, New York, N.Y. 10001.
2. "Life Between the Tides." Encyclopedia Britannica Films, Chicago, Ill. 60611.
3. "Beach and Sea Animals." Encyclopedia Britannica Films, Chicago, Ill. 60611. 11 min.

Tide Pools and the Rocky Intertidal Zone

FOR THE STUDENT

Seeing examples of the sea plants and animals can be a problem. For instance, if all the school children in an area were to go collecting seashore animals, all the animals would soon be removed from the shore. In this day of oil spills and other tragedies to the life along our coast, we need to think about conserving even those species, such as barnacles and periwinkles, that seem innumerable.

Plants and animals of the intertidal zone are able to withstand wide changes in salinity (salt content of the water) and temperature as they are alternately flooded by the tide or exposed to the sun and rain. Thus, they are ideal for saltwater aquariums. However, the seaweeds produce substances that are antibiotic, and in an aquarium these will kill all the animals.

If you cannot make a field trip to an area with tide pools, you can make a tide pool aquarium for your class. A large glass jar or a plastic box can be used. Most aquarium stores now carry artificial seawater mix and guides on setting up saltwater aquariums. They also sell "Sealastic," a Dow-Corning product, to use to glue together your own all-glass aquarium. Marine organisms may be purchased from biological supply houses. Be careful not to overcrowd your aquarium. Organisms from New England are used to cold water. When the water is cold, it holds more dissolved oxygen and the animals use less; thus, the cooler the water, the more animals it will sustain. In the winter you can keep an aquarium cold by setting it on the window sill so that the outside side of the aquarium is outdoors. Close in the rest of the space under the window sash with wood panels as you would for an air conditioner or window fan in summer.

References

1. The Salt Water Aquarium in the Home, by Robert P.L. Stranghan. 1970. A.S. Barnes and Co., New York, N.Y. 360 p.
2. The Edge of the Sea, by Rachel L. Carson. 1955. Houghton Mifflin Co., Boston, Ma. 276 p.
3. The Life of the Seashore, by William H. Amos. 1966. McGraw Hill Book Co., New York, N.Y. 231 p.

BEACH, DUNE AND MARSH

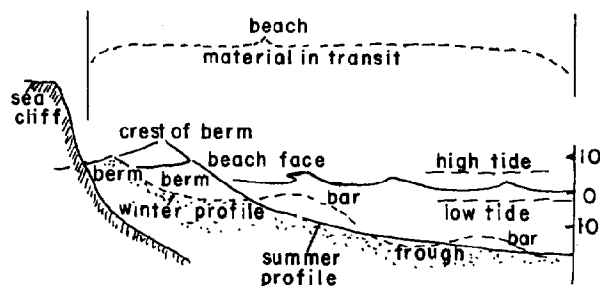
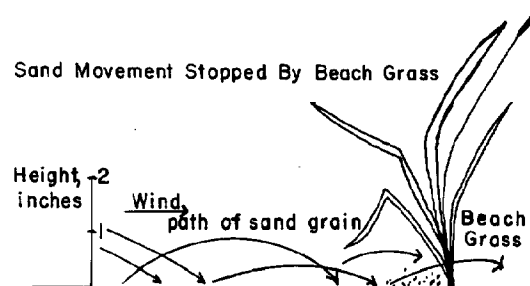
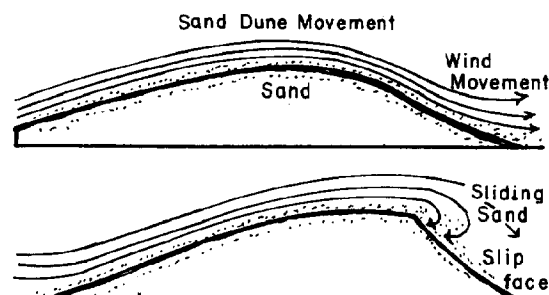
FOR THE TEACHER

Major Points

1. There is a striking contrast between the fall and early spring profile of a beach. The beach face is usually cut back by winter waves exposing the coarser sands. The winter profile is often jagged and irregular.
2. Plant and animal populations vary from one environment to another.
3. Dune grass, *Ammophila breviligulata*, stabilizes its environment. Each individual plant maintains a vast meshwork of roots and stems which holds the dune in place. Once the dune becomes stable it is colonized by a variety of plant and animal life.
4. The salt marsh is a nutrient trap. Again we find an environment dominated by one primary plant the marsh grass, *Spartina* sp. This plant absorbs the energy of the sun and the nutrients of the rivers and sea and releases them ever so slowly. The *Spartina* roots and stems produce a dense mat which traps organic nutrients to be gradually released into the environment. These nutrients are used directly by microscopic plants and animals . . . the start of a great food chain leading to the vast schools of fish populating our coast.

Activities

1. Beach:
 - a. Walk along the beach and observe the shells of animals that inhabit this particular environment.



Generalized profile through an intermediate slope beach showing seasonal changes in sand distribution.

- b. Compare and sketch the variation between fall and early spring beach profiles.
- c. With a hand lens you can easily distinguish the difference in particle-size between sand found above a cut (or cusp) and the sand found below. Why are they different?
- d. If time permits, dig a trench five feet long up and down the beach slope to observe the layering in beach formation. If you smooth off the side of the ditch and spray it with spray adhesive, you can press a piece of cardboard or paper against the sand and get a cross-section which you can take back to school to study.

2. Dunes:

- a. Try to identify the plants and animals that frequent this habitat.
- b. Observe the dune grass and compare the stability of areas with grass to those lacking grass. The areas devoid of grass should show evidence of being swept by winds which leave a conspicuous shallow trench-like structure.

3. Salt Marsh:

- a. Observe the primary feature of the marsh, a level plain dominated by one major plant type - Spartina sp.
- b. Identify the transition zone between the very tall cord grass and the shorter salt meadow hay. This illustrates the colonization of two slightly different habitats of mean high water and spring high water by two separate species of the same plant, cord grass, S. alterniflora and salt meadow hay, S. patens, respectively.
- c. Locate one of the many canals leading to the sea. Note the mat structure of its wall as well as the marsh animals inhabiting this zone.
- d. Locate the direction of freshwater flow into the marsh as well as the saltwater flow. How is the grass a nutrient trap for enrichment from both sources? Observe the dense growth and the tight root and stem interlacing.

References

Books:

1. Waves and Beaches, by W. Bascom. 1964. Anchor Science Study Series. Doubleday, New York, N.Y. \$1.45.
2. Life and Death of the Salt Marsh, by John and Mildred Teal. 1969. Little, Brown and Company, Boston, Ma. \$7.95.

Films:

1. "The Beach, the River of Sand" and "Seashore Life." Encyclopedia Britannica Films, Inc., Chicago, Ill. 60611.
2. "Between the Tides." Contemporary Films, Inc., New York, N.Y. 10001. 16mm., color, sound, 22 min.

Beach, Dune and Marsh

FOR THE STUDENT

The beach is a very dynamic environment. It changes from day to day with each rise and fall of the tide and change in weather pattern. The results of these daily changes add up to major seasonal changes.

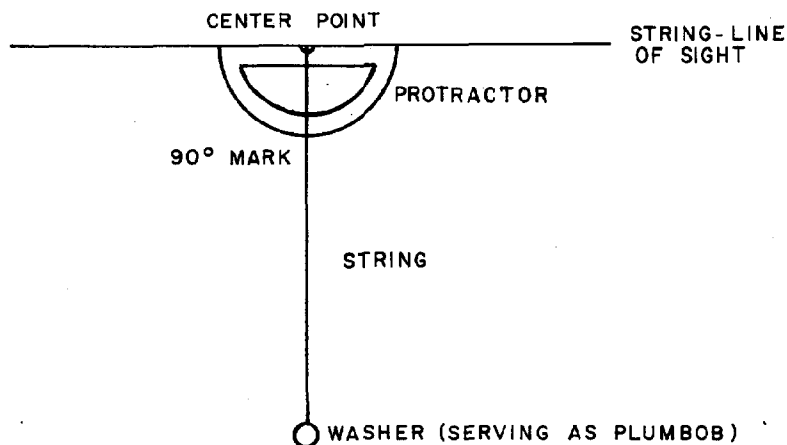
If you cannot get to a beach often, there are two times when you should definitely go: early fall and spring. In the fall you will see the beach built up to its maximum by the moderate wind and wave conditions of the summer. In the spring you will see the beach cut back by the strong winds and waves of winter.

If you really want to see nature's forces at work, go to the beach during or right after a storm. Then you will see how the winds carry the fine sand off the surface of the beach to form drifts, like snow drifts, which we call dunes. And you will also see how the high-energy storm waves blast the beach and carry away the sand leaving stones or "cobbles."

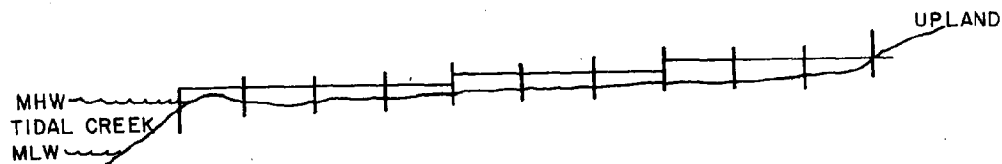
If you dig a trench on the beach with a shovel you will be able to see layers of different-sized materials. How are these layers formed?

The minerals that make up the sand vary from beach to beach according to the rocks which formed their source. Make a collection of sand samples from various beaches and examine the sand grains under a magnifying glass or a dissecting microscope. Note the kinds of minerals by size, shape and color from each beach. Get a book on rocks and minerals from the library and try to identify the minerals. Write schools or friends in other parts of the country and ask them to send you small samples of sand from their beaches for comparison.

If you can get to a beach or marsh make a "transect." A transect is a straight line across an area and can be used both to study changes in the elevation of an area and to sample the biological communities. To make a transect you will need some string, some stakes, something to measure with, such as a tape measure or yardstick, and something to level with, such as a carpenter's level, a line level, a protractor and plumbob or simply a line of sight along your transect to the far horizon where sea and sky meet.



Once you have a level line along your transect you can measure down from it to determine differences in elevation. On a calm day in the marsh you could wade out at high tide and measure down from the water's surface.



A marsh transect profile is an aid in mapping vegetation zones (vertical scale exaggerated).

Measure down from your line of sight or level line at intervals of five or ten feet and construct a profile on graph paper. Use a simple scale, like one foot equals one square on the graph paper, to draw your profile.

This is a very good way to study the changes in the shape of a beach. On your profile, note the plants and animals found along your transect. You will have to look hard for plants and animals on the open beach. There will be no problem finding them in the dunes and marsh. To make a study of the numbers of organisms per unit of area, you will need a frame that encloses a square foot, square yard or square meter. A hula hoop will serve nicely. Get your teacher to help you figure out the amount of area it encloses. Put your frame down at each point you measure elevation and count the number of each type of plant and animal within the frame. This is a "quantitative" sample.

A Reference

Life and Death of the Salt Marsh, by John and Mildred Teal. 1969. Little, Brown and Company, Boston, Ma. \$7.95.

SOUNDS OF THE SEA

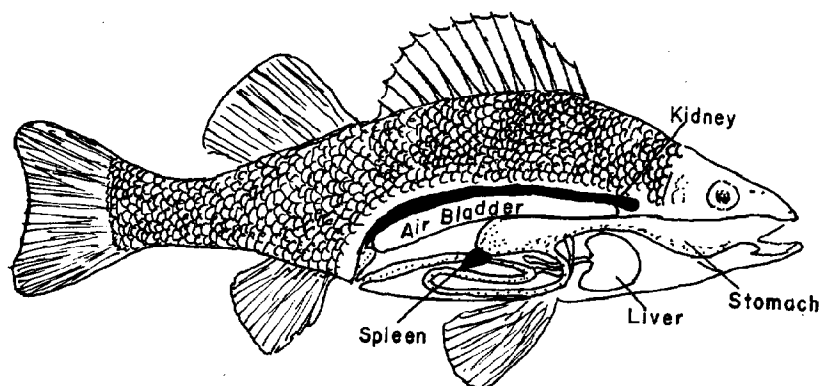
FOR THE TEACHER

Major Points

1. Sound is vibration; it travels faster in a dense medium like water than in air.
2. The underwater world is noisy, although our ears aren't capable of hearing all the noises.
3. Crustaceans make sounds by clicking together parts of their exoskeleton.
4. Many fish produce sound with aid of a swim bladder filled with gases which resonate when vibrated (see fish illustration).
5. Fish hear by means of ear and lateral line.
6. Cetaceans (whales, dolphins, porpoises) make sounds by blowing air through a blow-hole.
7. Man and dolphin use sonar for echo location, fish finding, echo sounding and detection of submarines.

Activities

1. Make or buy a cheap hydrophone. Then do experiments with lobster and fish sound amplification under water (see "The Amateur Scientist," Scientific American, Aug. 1970, p. 120).
2. Listen to records of underwater sounds.
 - a. "Song of the Humpback Whale," by Roger Payne of the New York Zoological Society, New York, N.Y. Capitol Record No. Stereo ST-620. Capitol Records, Inc., Hollywood and Vine Sts., Hollywood, Calif., \$3.77.
 - b. "Sounds of Sea Animals," Science Series, FX6125, Vol. 2, Folkways Records and Service Corp., 165 W. 46th St., New York, N.Y.
3. Make a plywood model of a fish with a balloon for a swim bladder.



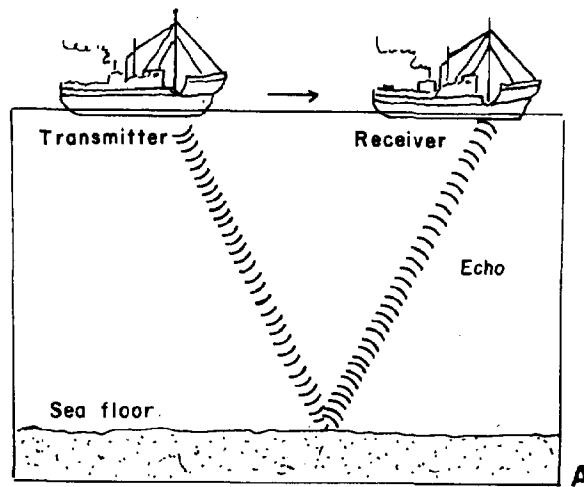
References

Books:

1. Dolphins: The Myth and the Mammal, by Anthony Alpers.
2. NOTE: In Oceanography (1970, W.H. Freeman Co., San Francisco) the following articles show how sound has been used to study the sea floor, biology and currents:
 - "The Continental Shelves," by K.O. Emery, p. 143.
 - "The Trenches of the Pacific," by Robert L. Fisher and Roger Revelle, p. 171.
 - "The Sea's Deep Scattering Layer," by Robert S. Dietz, p. 307.
 - "The Physical Resources of the Sea," by Edward J. Wenk, Jr., p. 347.
 - "The Circulation of the Abyss," by Henry Stommel, p. 72.

Films:

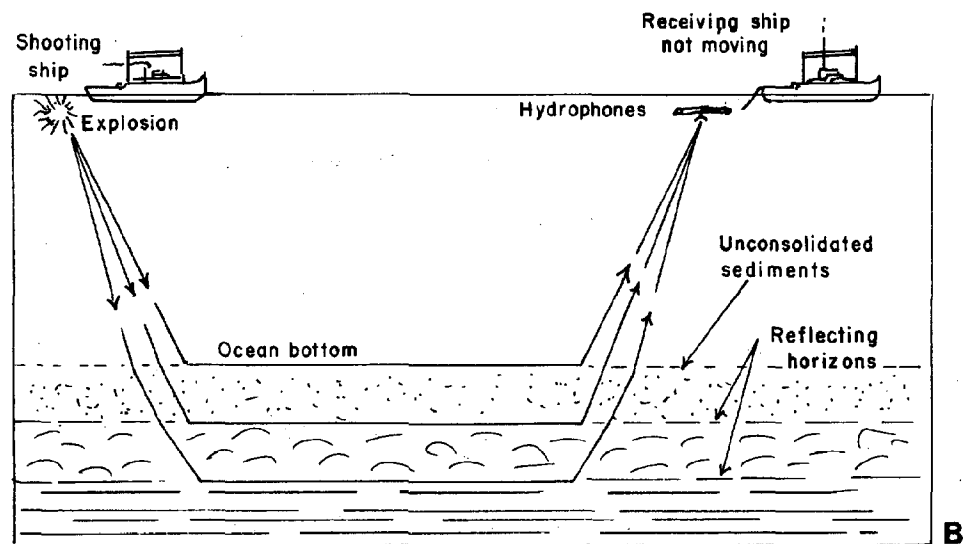
1. "The Noisy Underwater World of the Weddell Seal." Sterling Educational Films, Inc., 21 E. 34th St., New York, N.Y. 14 min.
2. "Sounds in the Sea." Educational Film Division, Moody Institute of Science, 1200 E. Washington Blvd., Whittier, Calif. 90606. 14 min.
3. "Sounds in the Sea." U.S. Navy Assistant for Public Affairs of your Naval District (when writing refer to MN-10409).
4. "Underwater Sound - Basic Principles." Graphic Arts Department, Woods Hole Oceanographic Institution, Woods Hole, Ma. 02543. Color, 21 min.



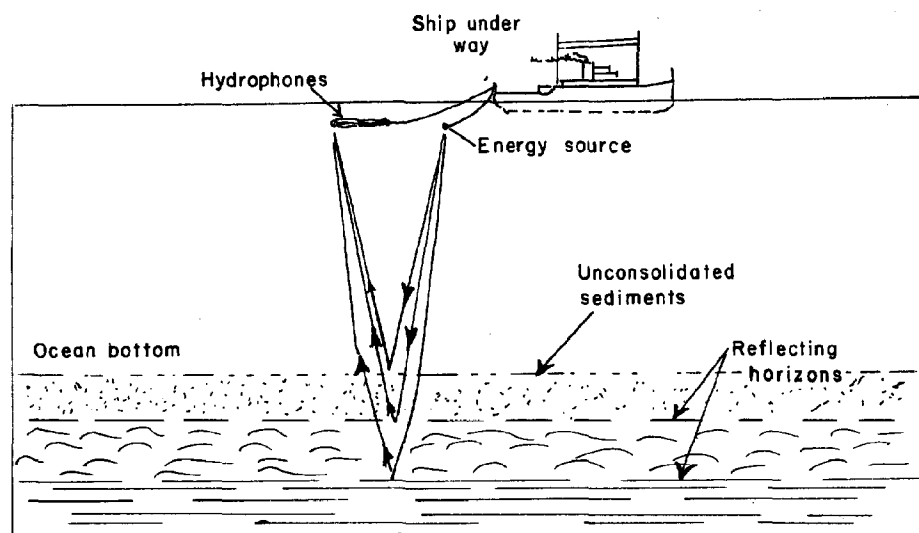
A - ECHO SOUNDING

B - SEISMIC REFRACTION

C - SEISMIC REFLECTION



B



C

Sounds of the Sea

FOR THE STUDENT

"The Song of the Humpback Whale" has become quite a popular record recently. Perhaps your school or community library has a copy. There is another record available commercially entitled "Sounds of Sea Animals."

Man has found sound a very useful tool in the sea. Because of the speed of sound in water it is useful for determining the depth of the water, or the location of ships, submarines and fish. It is also used at sea (and on land) by seismologists to study the structure of the earth's crust.

Because the speed of sound varies with the density (mass per unit volume) of water, it is frequently necessary to know the temperature and salt content of the water in order to use sound to measure distances accurately. As sound waves pass from warm water to cold (from less dense to more dense water) they are bent (refracted) in a manner similar to the way light is bent when it passes through a glass of water or the sides of an aquarium. Thus, you can see how important it was during World War II to learn about the density structure of the oceans in order to hunt down enemy submarines and for our submarines to evade detection.

If you live near a lake or the ocean you may wish to build a simple hydrophone. There have been plans for several in "The Amateur Scientist" column of the Scientific American. The simplest and cheapest one should cost less than \$2.00 to build. The plans are on page 120 of the August, 1970 issue. More sensitive and sophisticated hydrophones are described in the October, 1960, and March, 1964 issues. However, these are also more expensive, require special materials and tend to accentuate sounds of high pitch.

If you know someone who has a boat equipped with a recording echo sounder, ask for a recording made while the boat is moving in a straight line between two known points. Compare the depths with those on a navigation chart. Perhaps the boat owner can show you traces that indicate various species of fish. "Echograms" are frequently used for both navigation and fish finding by both commercial and sport fishermen.

References

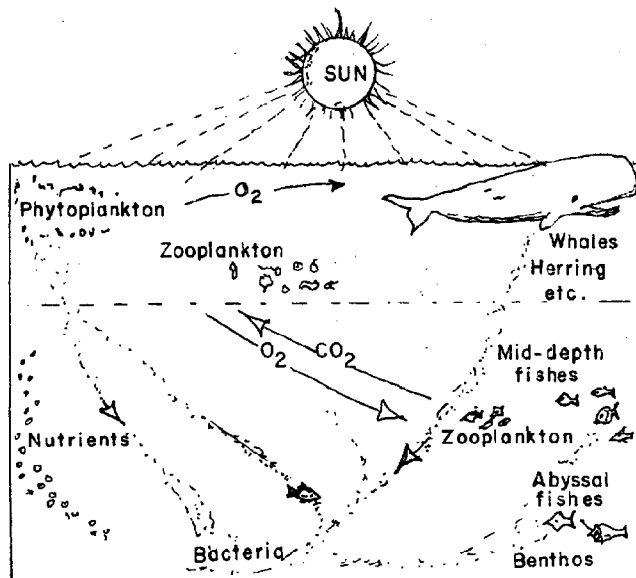
1. "Piloting, Seamanship and Small Boat Handling," Motor Boating, p. 352(n), New York, N.Y. 665 p. \$7.95.
2. "Sounds of Sea Animals." Folkways Science Series, Folkways Records and Service Corp., 165 W. 46th St., New York, N.Y. FX6125, Vol. 2.
3. "Song of the Humpback Whale." Capitol Records, Inc., Hollywood and Vine Sts. Hollywood, Calif. \$3.77.

MARINE FOOD CHAIN

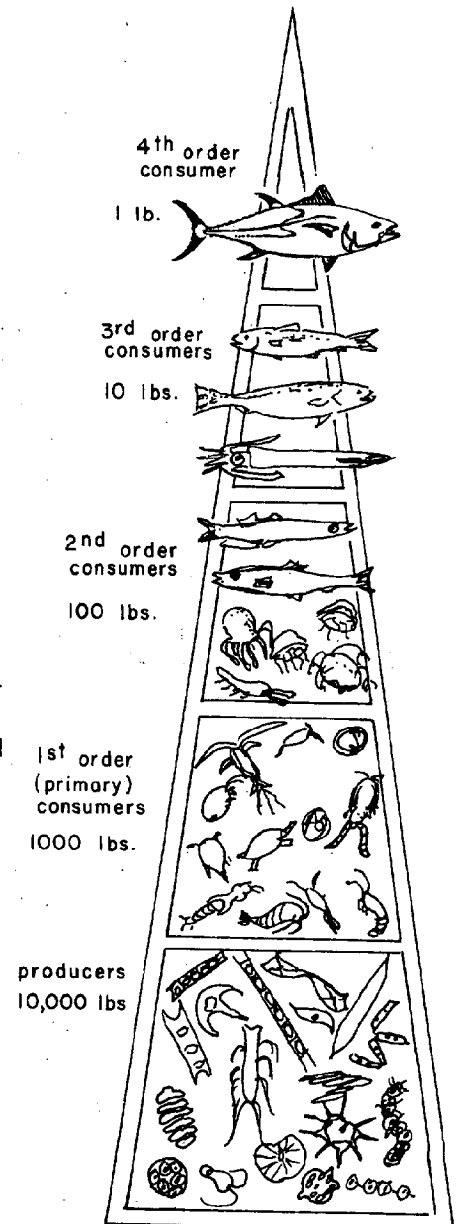
FOR THE TEACHER

Major Points

1. What is plankton--the free-floating plants and animals that form the first two stages of the marine food chain.
2. Importance of plankton to organisms such as tuna.
 - a. Primary (first-level) productivity - the capture of the sun's energy by plants
 - b. Primary producers -- phytoplankton -- the microscopic, free-floating "grass of the sea"
 - c. Transfer of energy up the food chain to higher level organisms
3. The ability of an area of ocean to produce and nourish plankton depends on the availability of nutrients.
4. Seasonal and geographic variations in planktonic populations.
 - a. Upwellings - areas of nutrient rich water.
 - b. Currents
 - c. Temperature and salinity
5. As a rule of thumb, it takes 10,000 pounds of primary producer (phytoplankton) to produce one pound of fourth-level consumer. However, the reverse is true for substances, such as heavy metals, which are not metabolized but are accumulated in the food chain. At the fourth level they may be concentrated 10,000 times over their natural concentration in the environment.



A schematic representation of some marine food chains.



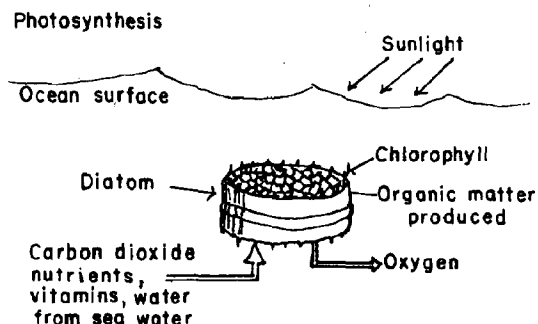
To gain one pound, a tuna (fourth-order consumer) must eat the equivalent of 10,000 pounds of planktonic plants (producers).

6. Breaking the thread--pollution and exploitation of environment and species upsetting natural balance
 - a. Overfishing
 - b. Oilspills

Classroom Activities

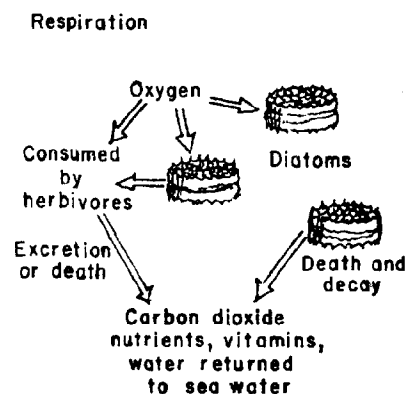
1. Food Web game

- a. Cut out several models of producers and first-through fourth-level consumers.
- b. Give one to each student making sure you hand out more producers than first-order consumers, etc.
- c. Have teacher begin connecting string from one member of food chain to next in order of their consumption. Make sure string interconnects to show variations in diet.
- d. When done, have students hold this web over their heads (good example of "food web").
- e. Begin cutting threads while proposing various problems such as:
 - (1) This phytoplankton was eaten.
 - (2) This one didn't receive enough sun.
 - (3) This consumer died of oxygen decrease due to bacteria buildup.
 - (4) An oilspill polluted the water to kill these.
- f. Discuss importance of understanding and possibly managing food chains.



2. Importance of balance: effects of a fertilizer on growth of algae

- a. Take two 30-gallon tanks of seawater or fresh water; label one "Control" and one "Experimental" and place them in a sunny window.
- b. Each day add 1/2 teaspoon of a household phosphate detergent or fertilizer 10-10-10.
- c. Record water temperature, turbidity, general appearance. Is algae growing? Continue until algal bloom makes water very turbid and green.
- d. Questions:
 - (1) Why is water green?
 - (2) Is there any difference between two tanks? (Explain difference.)
 - (3) How can any difference be related to areas of upwelling?
 - (4) How does this compare with algal pollution?



Field Activities

1. Observe feeding behavior of crabs, sand fleas or mummichogs, recording what is eaten, approximately how much, and how often. Are these organisms eaten? If so, by what?

2. Plankton tow - identify major types of zooplankton.

References

Books:

1. "The Nature of Oceanic Life" in Oceanography, by John D. Isaacs. 1971. W. H. Freeman and Company, San Francisco, Calif., 417 p. \$5.75.
2. Frontiers of the Sea, by Robert C. Cowen, Bantam Books, Inc., New York, N.Y.
3. Phytoplankton - Grass of the Sea. 1970. Sea Grant No. 9, Extension Marine Advisory Program, Oregon State University, Corvallis, Ore. 97331. Free

Films:

1. "Plankton and Open Sea," Krasker Memorial Film Library, Boston University, School of Education, Boston, Ma. 02215.
2. "Marine Animals and Their Food." Coronet Films, Chicago, Ill. 60601. Color, 8 min.

Marine Food Chain

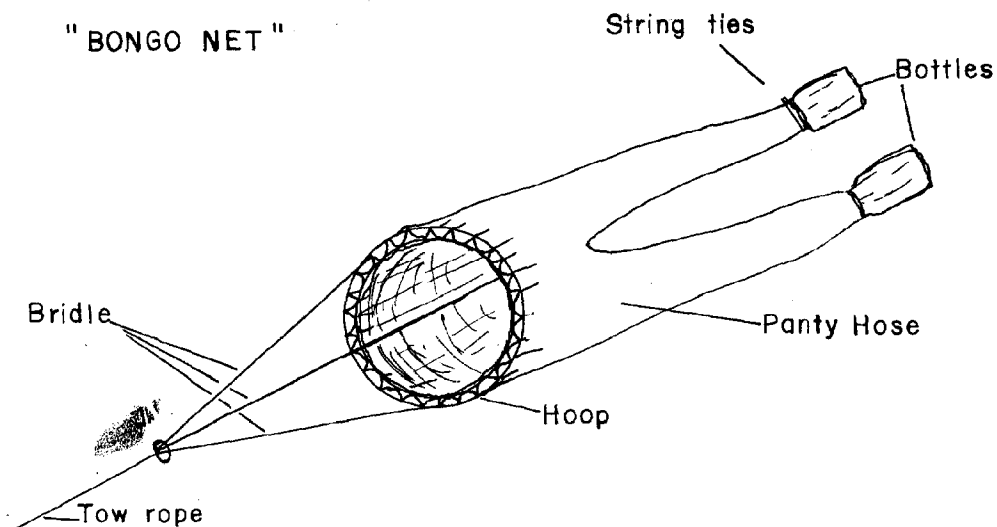
FOR THE STUDENT

Plankton are the small, free-floating organisms of the sea. As on land, in the sea the green plants combine carbon dioxide with water, utilizing energy from the sun, in the process called photosynthesis to form simple sugars, which are the basis for the food upon which all other life depends. Except in the shallow waters of the salt marsh, it is the algae, not the flowering plants, which carry on this process in the sea.

Along the fringes these algae consist of large attached forms which we all know as seaweed. But the vast majority of the photosynthesis which goes on on this planet is carried out by the single-celled plants known as phytoplankton.

One of the by-products of photosynthesis is oxygen, which we as animals need to release the energy required by our bodies to carry out all the life processes. Over 70 percent of the world's oxygen is produced by the phytoplankton. These energy fixers are termed primary producers and are the first step in the food chain of the sea. They are eaten by the tiny animals called zooplankton which in turn are eaten by small fish and other animals which in turn are eaten by bigger fish, etc. Thus, we have first, second, third and sometimes fourth-level consumers in the food chain.

You can make a plankton net from an old nylon stocking or a pair of pantyhose. Make a loop of wire (a couple of coat hangers will do) or use an embroidery hoop to hold open the mouth of your net. Roll the mouth around your hoop several times and bind it in place with strong or heavy string or light rope to which you can attach your towline. Put a small jar in the toe of each leg and tie a string around the foot of the stocking at the neck of each jar.



You can tow this net with a rowboat or let it stream in the current from the bridge. You can even attach it to a fishing line and with practice you can cast it out and reel it in. This will give you a sample of the kinds of plankton in the water. We call this a "qualitative" sample.

To determine the numbers of organisms per gallon, cubic foot or other measure of volume (cubic meter is the measure usually used by scientists) you need to know how much water is filtered through the net. The easiest way to do this is to collect the water and then pour a known volume through the net. A bucket is fine for this purpose if you just want to sample the surface. A pump that pumps so much water per minute or per stroke is good because then you can sink a hose down to the level you wish to sample and pump away.

You'll need to use a dissecting microscope to look at most zooplankton and a compound microscope to look at phytoplankton. For more information you should order the book Plankton Primer and its accompanying wall chart for \$1.00 from: Martek Instruments, Inc., 879 W. 16th St., Newport Beach, Calif. 92660.

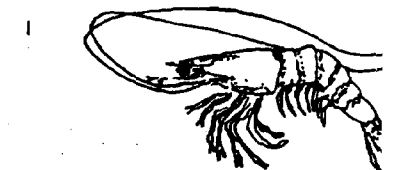
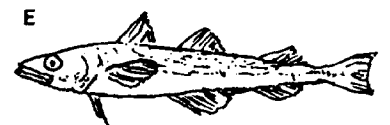
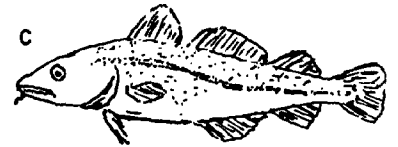
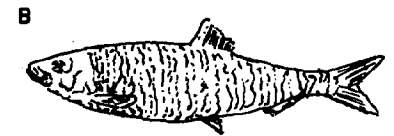
CORNUCOPIA OF THE SEA

FOR THE TEACHER

Major Points

1. There are many unexploited species of marine plant and animal life. Of the more than 20,000 species of fish only about a dozen kinds make up the bulk of fish used as food. Many marine animals such as squid, sharks and snails are fine food sources but are not used in many countries because they are not a familiar food. Others such as lantern fish and bristlemouths which could be used in fish meal are not caught because inexpensive methods of catching them in their deep ocean habitat have not been developed.
2. At the present time, only a very small portion of man's protein is obtained from the ocean. Many new sources and ways to use it is being tried. A tiny shrimp-like crustacean from the Antarctic, the Krill (*Euphausia superba*) may be a future source of protein for man. Experiments are being made with a concentrated fish protein in the form of a flour which can be made into high-protein bread.
3. The principal fishing nations are Peru, Japan, China (mainland), U.S.S.R., Norway and the U.S. But many developing nations have begun to take to the oceans to fill their great need for protein. Almost the whole catch of 10 million tons a year in Peru is one fish, the anchovy (*Eugraulis rigens*), which is made into fish meal. Both Japan and the U.S.S.R. have far-ranging fleets which not only catch but process (can, freeze, prepare by-products) the fish too.
4. The resources of the oceans are great but not unlimited. Many areas and species are being over-exploited and unless international agreements can be reached and enforced to prevent over-fishing, more things like the decline of the Antarctic baleen whale and the California sardine will occur.
5. The maximum sustained yield is the largest amount which can be taken from a stock of fish year after year without causing a decrease in abundance. By determining this for each stock of fish protective quotas could be devised which would safeguard the oceans' plenty.

Largest marine catches (millions of metric tons, 1967):
 A. Peruvian anchoveta, 10.5; B. Atlantic herring, 3.8;
 C. Atlantic cod, 3.1; D. mackerel, 2; E. walleye pollock, 1.7; F. South African pilchard, 1.1; G. oysters, .83; H. squid, .75; I. shrimp and prawn, .69; J. clams and cockles, .48.



6. The farming of the oceans and their tributaries, (aquaculture) is a growing industry. In Japan many types of algae, the best known being Porphyra, are grown as crops. Oysters are hatched and cultivated in the U.S., Japan and Australia. Shrimp and prawn are raised in Japan, Singapore and India. In marine fish farms in Indonesia, the Phillipines, Taiwan and Italy, the milkfish (Chano chanos) and grey mullet (Liza sp.) graze on algal felt which covers the bottom of the carefully tended fish ponds.

Activities

1. Trips
 - a. Visit processing and fish supplement plants.
 - b. Go to seafood restaurant.
 - c. Collect specimens that are native to your area.
 - d. Visit an aquaculture enterprise.
2. Projects
 - a. Have class reports on seafood use and consumption in various countries.
 - b. Publish pamphlet of collected and original seafood recipes.
 - c. Collect or draw pictures of animals and plants used for seafood.
 - d. Have a classroom seafood dinner (possibly combined with 1 c & 3 b).
 - e. Give reports on drugs and other important by-products from animals and plants of the sea (present and ancient).
 - f. Make up meal charts for school display.
 - g. Plan a shipwreck manual on how to survive using available sea life.
 - h. Do research on protein supplements and their present and future use.
3. Discussion and Group Topics
 - a. Stage an international "Law of the Sea" conference showing the problems and progress in protecting the ocean's natural resources.
 - b. Invite local fish warden to discuss cautions needed in securing sea organisms for eating purposes and the laws governing collection.
 - c. Discuss variety of life found in sea.
 - d. Debate the question "Is the sea the answer to the world's future food needs?"

References

Books:

1. Seaweeds and Their Uses, by V.J. Chapman. 1952. Barnes and Noble, New York, N.Y. \$14.50.
2. Farming the Edge of the Sea, by Fishing News Ltd. London, England. 1968.

3. Stalking The Blue Eyed Scallop, by Euell Gibbons. 1964. David McKay Co. New York, N.Y. (hardcover \$7.95, paperback \$2.95).
4. Stalking Wild Foods on a Desert Isle, by Euell Gibbons. National Geographic, July 1972, 47 p.
5. The Food Resources of the Sea, by S.J. Holt, in "Oceanography," J. Robert Moore, ed., W.H. Freeman and Co., San Francisco, California, 1971. (paper \$5.75).
6. Marine Products of Commerce, by Donald K. Tressler and James W. Lemon, Reinhold Publishing Corp., New York, N.Y.
7. Marine Resources of the Atlantic Coast, by Atlantic State Marine Fisheries Commission, P.O. Box 2784, Tallahassee, Florida. 32304. Series of 14 leaflets-\$1.78 (commercially important species of fish and shellfish-illustrated.)

Charts: (see page 36).

Films:

1. "41 North 67 West," Mass. Seafood Council, Fish Pier, Boston, Mass. 02210.
2. "Seafood Favorites from the Seafood State," Association Sterling Films, 484 King Street, Littleton, Mass. 01460. (color-free).

NOTE: The films on this list are available free from Audio-Visual Services, NMFS, 1815 North Fort Meyer Dr., Arlington, Va. 22204:

- | | |
|-----------------------------|-----------------------------|
| 3. "Japan Harvests the Sea" | 6. "It's the Maine Sardine" |
| 4. "New England Fisherman" | 7. "Fresh Out of the Water" |
| 5. "The Story of Menhaden" | 8. "Salmon Catch-To-Can" |

NOTE: The films on this list are available from Department of Sea and Shore Fisheries, State House, Augusta, Maine:

- | | |
|-------------------------------------|-----------------------------------|
| 9. "Filleting and Packing of Fish " | 12. "Seed Quahog Dredge " |
| 10. "Maine Alewife Fishery " | 13. "Waterman of the Chesapeake " |
| 11. "The Maine Lobster " | |
14. "The Hidden Treasure," Seafood Marketing Authority, 94 College Avenue, Annapolis, Maryland. 21401. (free)

Cornucopia of the Sea

FOR THE STUDENT

Vast areas of the ocean are barren. Only where nutrients are found near the surface where light can penetrate and plants (phytoplankton) can grow is the ocean highly productive. These areas are located on the continental shelves and in areas where upwelling brings bottom water to the surface. Despite the fact that these areas only constitute a small part of the total ocean surface they account for approximately 70% of all the photosynthesis (primary productivity) on earth and it is in these areas that our great fisheries are found. Some of these areas have been exploited by man for thousands of years, while a few are just now being tapped. The most abundant species are those which graze directly on the phytoplankton (first-order consumer) or on the zooplankton (second-order consumer). Some of these such as the Peruvian Anchoveta and the Atlantic menhaden are oily and distasteful to man. These are used in the "industrial fishery" to make animal food supplements, high protein flour and valuable oils. Man seems to prefer to eat third-and fourth-level consumers such as cod, haddock, tuna and salmon. But man also is a creature of habit and in sticking to traditional species overlooks many very tasty and nutritious species of fish and shellfish.

Activities

1. See how many species of fish you can find in your local stores.
2. Look at Euell Gibbons' book Stalking the Blue Eyed Scallop and see how many edible species he lists that aren't in the stores.
3. Try eating different kinds of seafood. Don't let looks bother you, go by taste. Try new ways of cooking fish.

Seafood is especially good for you because it is high in vitamins, minerals, and protein. It is very low in fat.

References

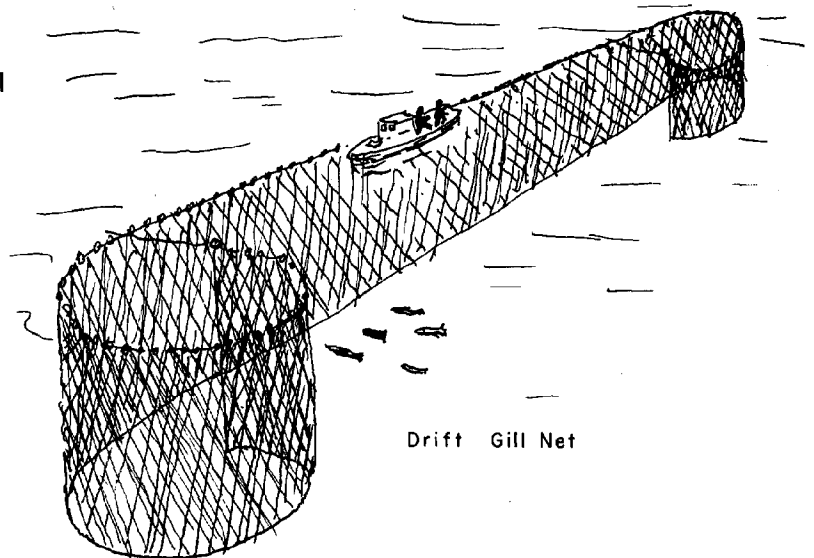
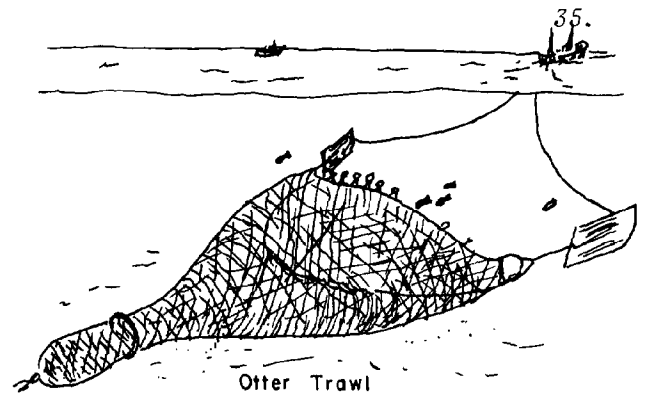
1. Stalking the Blue Eyed Scallop, by Euell Gibbons. 1969. David McKay Company, Inc., New York, N.Y. (hardcover \$7.95, paper \$2.95).

COMMERCIAL FISHING

FOR THE TEACHER

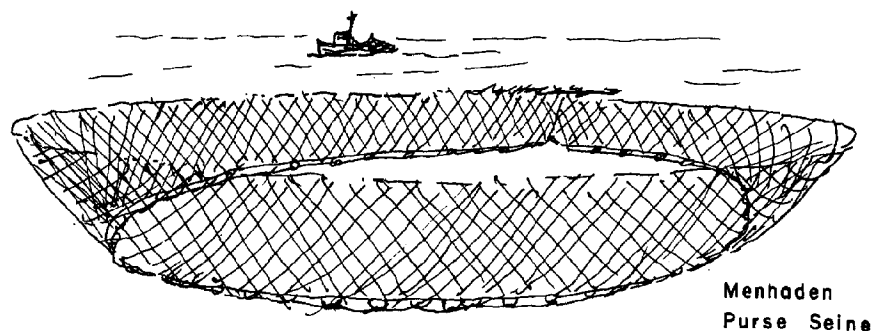
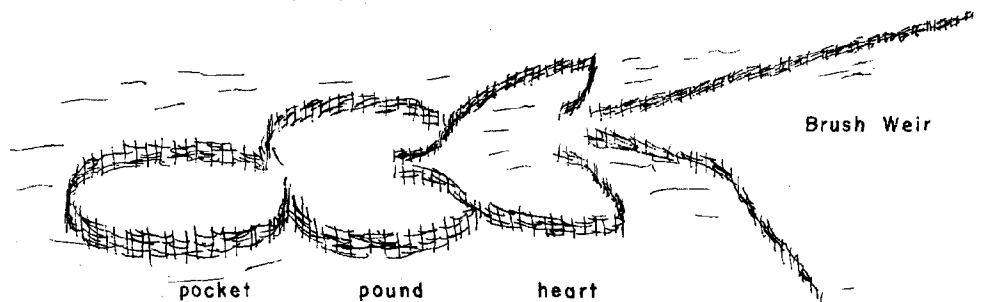
Major Points

1. Productivity of sea - the food resources
2. Equipment and methods of obtaining (catching) fish and other useful organisms
3. Economic importance of commercial fisheries
4. Problems of commercial fisheries
 - a. Depletion of organisms
 - (1) overfishing
 - (2) pollution
 - b. Competition with other nations
 - c. Marine law
5. Mariculture
 - a. Oysters and other shellfish
 - b. Algae



Activities

1. Classroom.
 - a. Chart zones of ocean favorable for fishing.
 - b. Map and discuss major fishing ports of world and local fishing ports.
 - c. Show factory ships - design and uses.
 - d. Discuss law of sea - state, federal and international laws.
 - e. Determine age of fish using fish scales and/or otoliths.



36.

2. Field.

- a. Visit fish pier, like Boston Commercial Fish Pier.
- b. Visit fish processing plant, like Booth Fisheries, New Hampshire.
- c. Visit a mariculture station for oysters.
- d. Visit trash fish processing plant.
- e. Make your own seafood meal.
- f. Go out on a commercial fishing vessel.

References

1. The Old Man and the Sea, by Ernest Hemmingway.
2. The Frail Ocean, by Wesley Marx. Ballantine Books, Inc., New York, N.Y.
3. Marine Products of Commerce, by Donald K. Tressler and James W. Lemon. Reinhold Publishing Corp., New York, N.Y. (SH 335 T7).
4. "The Nature of Oceanic Life," by John D. Isaacs, p. 215; "The Food Resource of the Sea," by S.J. Holt, p. 356; "The Ocean and Man," by Warren S. Wooster, p. 219. Oceanography: Readings from the Scientific American. 1970. W.H. Freeman and Co., San Francisco, Calif. 417 p. Paper \$5.75.
5. Marine Resources of the Atlantic Coast, a series of 14 leaflets covering commercially important species of fish and shellfish, very well illustrated. Atlantic States Marine Fisheries Commission, Washington, D.C. \$1.78 for the series.
6. A Guide to Fishing Boats and Their Gear, by Walter G.P. Blair. 1966. Putnam and Sons, New York, N.Y. 128 p. \$3.49.
7. Harvest of the Sea, by John Bardach. 1968. Harper and Row, New York, N.Y. 301 p. \$1.95 (paper)

Charts

1. Wall charts (in color) of commercially important species from James Hooke Co., Inc., Boston, Ma., \$5.00, or International Marine Publishing Co., Camden, Me., \$5.00.
2. "Marine Fishes of the North Atlantic," a colorful wall chart produced by National Marine Fisheries Service and available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. \$1.50.
3. Common Marine Fishes of the United States, National Marine Fisheries Service Form FH-6, available from the New England Marine Resources Information Program, Narragansett, R.I. 02882.

Subscribe to:

National Fisherman, a monthly newspaper which not only covers commercial fishing, but also much of the art, literature and history associated with the sea, as well as maritime trade, boat and ship building, etc. National Fisherman, Camden, Me. 04843. \$6.00/year.

Films (See list, page 33.)

Commercial Fishing

FOR THE STUDENT

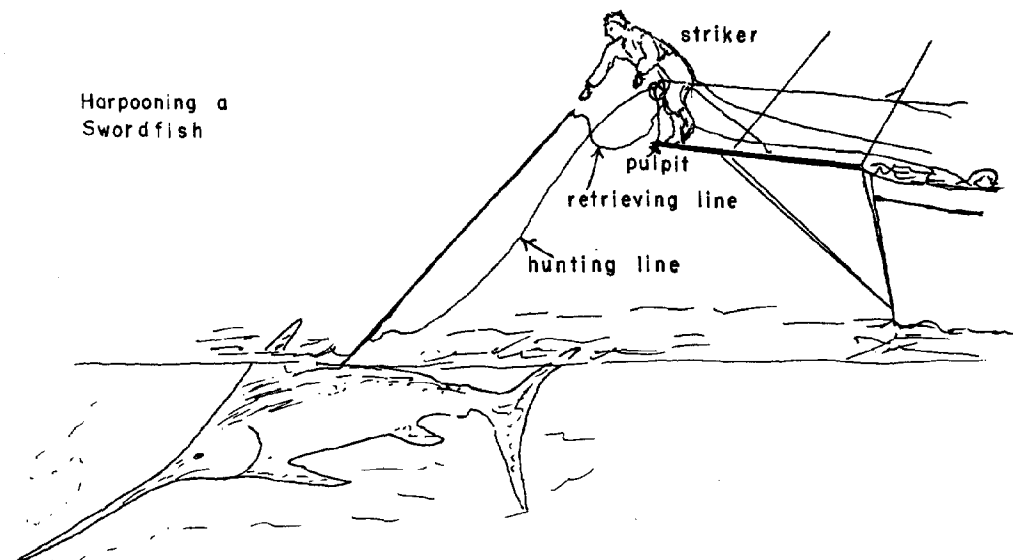
Visit a commercial fishing port if possible. Don't be afraid to ask questions. Many fishermen are willing to talk about their work if asked.

Ask you teacher, school librarian or town librarian about subscribing to the National Fisherman. In many coastal communities this monthly newspaper can be bought at newspaper dealers. A subscription costs \$6.00 per year and can be obtained by writing National Fisherman, Camden, Me. 04843.

Try to learn all you can about a particular kind of fish, fishing boat, type of net or other gear. Make a model of the net, boat or gear and explain how it works to your classmates.

References

1. The Frail Ocean, by Wesley Marx. 1967. Ballantine Books, Inc., New York, N.Y. 274 p. paper - 95¢.
2. The Sea Around Us, by Rachel Carson. 1961. Oxford University Press, New York, N.Y.



BOATS

FOR THE TEACHER

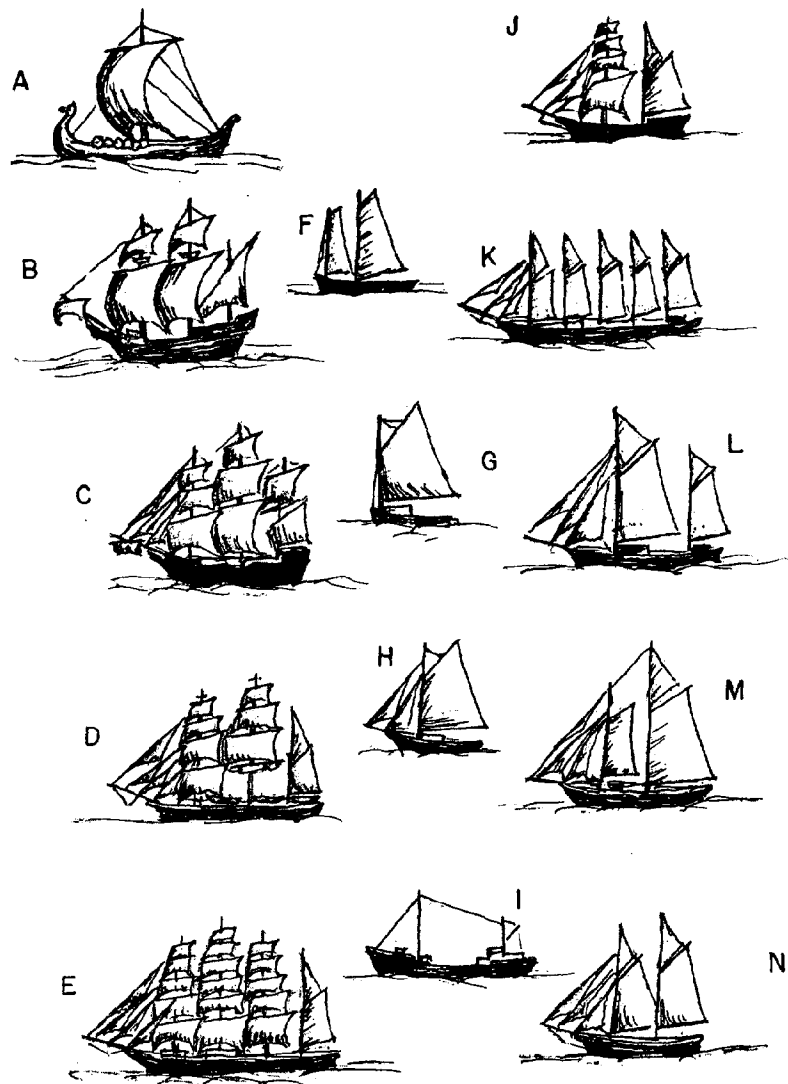
1. The construction of boats and ships has undergone very gradual evolution from the time man first floated on a log raft.
2. Though man's vessels varied greatly in size, shape and sophistication, they were nearly all made of wood until the middle of the last century. Even after wood was replaced in shipbuilding by other materials such as steel boats and ships were each individually designed and custom built. Thus every new ship was in many ways an experiment.
3. Today boats and ships are made of concrete, steel, copper/nickle alloy, aluminum, fiberglass and the old reliable, wood. Many of these materials have lent themselves to mass production techniques which allow the fabrication of proven designs at reasonable cost for the boating public. During World War II "Victory" and "Liberty" ships as well as fighting ships were mass produced. But many boats and ships continue to be custom made.

Activities

1. Have the class make a list of all the types of ships used in modern commerce.
2. Study the evolution of boat and ship design in the last two hundred years. How are today's boats different from the ships of Columbus, Leif Ericson, or the Romans?
3. Visit a marine museum, boatyard, shipyard, or offices of a naval architect.

References

1. Piloting, Seamanship and Small Boat Handling, by Charles F. Chapman, (pub. each year) Motor Boating, 959 Eighth Avenue, New York, N.Y. \$7.95.
2. The History of American Sailing Ships, by Howard I. Chapelle. 1935. Norton Pub. New York, N.Y. \$25.00.
3. A Guide to Fishing Boats and Their Gear, by Walter G.P. Blair. 1966. Putnam and Sons, New York, N.Y. 128 pp. \$3.49.
4. Practical Ferro-cement Boatbuilding, by Jay R. Benford and Herman Husen. 1971. International Marine Publishing Company, Camden, Me. \$10.00.
5. Boatbuilding Manual, by Robert M. Steward, 1970. International Marine Publishing Company, Camden, Me. \$9.50.



Types of boats that sailed the New England Coast: A. Viking Longship; B. Carrack; C. Caravel; D. Whaling Bark; E. Four-Masted Bark; F. Two-Masted Catboat; G. Cape Cod Catboat; H. Friendship Sloop; I. Dragger; J. Brigantine; K. Five-Masted Schooner; L. Fishing Ketch; M. Fishing Schooner; N. Coastal Schooner.

- ANSWERS**
1. ☐ T ☐ F When two boats approach at an angle and there is danger of collision, the boat to port must give way to the boat to starboard. (See RULES OF THE ROAD)
 2. ☐ T ☐ F When overtaking another boat, the right of way belongs to the boat being overtaken. If your boat is being passed, you must maintain course and speed. (See RULES OF THE ROAD)
 3. ☐ T ☐ F When heading out to sea, the black buoy should be on the starboard side. (See Navigation Aids—"RED RIGHT RETURNING" RULE)
 4. ☐ T ☐ F Red triangular pennant indicates small craft warning. (See STORM WARNING SIGNALS)
 5. ☐ T ☐ F Always keep to starboard in a narrow channel. Thus, boats would pass "port to port". (See RULES OF THE ROAD)
 6. ☐ T ☐ F This is a "diver down" flag and indicates a diver in the immediate area. Stay well clear. (See SKIN AND SCUBA DIVING)
 7. ☐ T ☐ F Engine and propeller should be completely stopped. (See WATER SKIING)
 8. ☐ T ☐ F All boats must have required lighting when underway between sunset and sunrise. (See NAVIGATION LIGHTS)
 9. ☐ T ☐ F When returning from the sea, the red buoy should be on the starboard side. (See Navigation Aids—"RED RIGHT RETURNING" RULE)
 10. ☐ T ☐ F The sailboat has the right of way. Therefore, boat "A" should steer to port. (See RULES OF THE ROAD)
- ENJOY BOATING**
MORE—PRACTICE
SAFETY OFFSHORE

Answers to quiz in student guide, next page.

Boats

FOR THE STUDENT

Probably the most fascinating thing about a boat is that it floats. This is due to the principal of buoyancy. It is obvious to even a casual observer that a piece of styrofoam is very light and therefore it is logical that it should float on water. It is less obvious why a ship made of steel (which we know is too heavy to float on water by itself) should float. To understand buoyancy thoroughly it is necessary to be able to determine the mass of an object and the mass of the water which that object displaces when it is submerged in water. A simpler way to gain a feeling for buoyancy is to make clay boats.

Activity

Take modeling clay and work it into a solid ball. Place it in a bowl of water. Does it float? Try other solid shapes such as a cube or a pyramid. Do they float? Now shape the clay into the shape of a bowl. Does it float? Make the sides of your bowl thinner. Now does it float? See how big a bowl you can make from your original piece of clay. You may wish to roll it out with a rolling pin or shape it over a pan or some other mold. Now does it float? Can it carry a load? How much of a load? How is it different from the original ball of clay? Now do you understand how a boat can be built of concrete or steel? Is it necessary for a ship to be built of a material such as wood which is lighter than water? Why don't we make rafts of rocks to paddle around on the mill pond? Could you make a boat out of stone? How?

ARE YOU ALL AT SEA ABOUT BOATING SAFETY?

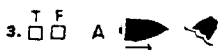
TRY THIS QUICK QUIZ



BOAT "A" MUST GIVE WAY TO BOAT "B".



BOAT "A" IS OVERTAKING BOAT "B".
BOAT "B" MUST SLOW DOWN AND TURN TO PORT.



THIS BOAT IS HEADING OUT TO SEA AND
SHOULD KEEP THE BLACK BUOY ON ITS
PORT SIDE.

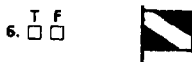
4. ☐ T ☐ F



SMALL CRAFT SHOULD NOT VENTURE OUT
WHEN THIS PENNANT IS FLYING.



IN A NARROW CHANNEL, BOTH BOATS
SHOULD PASS "PORT TO PORT".



BOATS FLYING THIS PENNANT ARE IN
DISTRESS.



ENGINE AND PROPELLER SHOULD BE COM-
PLETELY STOPPED BEFORE PICKING UP
FALLEN SKIER.



ONLY BOATS OVER 16' ARE REQUIRED TO
BE EQUIPPED WITH LIGHTS WHEN UNDER-
WAY AFTER SUNSET.



THIS BOAT IS ENTERING FROM SEAWARD.
IT SHOULD KEEP THE RED BUOY ON ITS
STARBOARD SIDE.



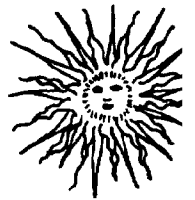
IN THIS SITUATION, BOAT "A" SHOULD
STEER TO STARBOARD.

NAVIGATION

FOR THE TEACHER

Major Points

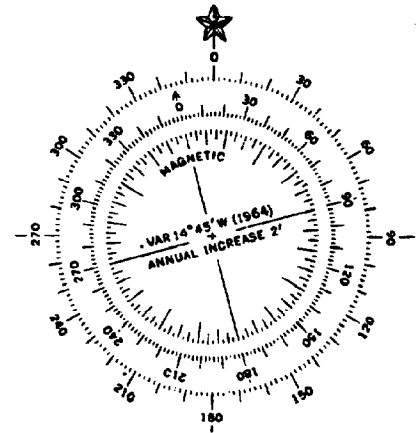
1. Seven thousand years ago the Sumerians of Mesopotamia exported their goods by vessels belonging to a seafaring people called the Magans, who sailed the Persian Gulf.
2. Best known of the ancient sailors are the Phoenicians. These seafaring merchantmen of 2000 B.C. sailed to Britain for Cornish tin, to Norway for dried fish. They sailed south from the Red Sea via Cape of Good Hope and home through the Straits of Gibraltar. We cannot even guess how these masters of the sea found their way since they wrote little of their voyages, wanting to keep their trade routes and sources of cargo a secret.
3. The ancient Polynesians made bamboo charts to help guide their way among the Pacific Islands. They understood the language of the sea and followed varying colors of ocean currents, cloud patches hanging over every tropical island, wave patterns and migrating flocks of birds and schools of fish.
4. In the ninth century A.D. the Vikings through their seamanship and without instruments sailed throughout the waters of the North Atlantic. In the year 1000 A.D. Leif Ericson landed somewhere along the North American coast between Cape Cod and Newfoundland and started several small colonies.
5. The rediscovery of celestial navigation and the early compasses after the Dark Ages (about 1300 A.D.) mark the beginning of modern navigation. Such men as Prince Henry of Portugal, Columbus, and Magellan all added to this new science of navigation.
6. While these early navigators could determine latitude (distance north or south of the equator from the altitude of the sun above the horizon and from the movements of various stars), they could not determine longitude (distance east or west of their starting point) until the invention of the chronometer (a very accurate portable clock).



The astrolabe was used to measure the height of the sun and stars above the horizon from 150 B.C. to the end of the 16th century.

7. Captain Cook was the first navigator to sail with a chronometer. His voyages were considered of such scientific importance that he carried a letter of free passage from Benjamin Franklin which allowed him to carry out his surveys unmolested during the American Revolution.
8. Today we are in an age of instantaneous electronic navigation with such instruments as radar, sonar, loran, inertial guidance systems, and satellite navigators. With accurate charts, depth finder, and radio direction finder, even a weekend sailor can quickly locate his position and feel secure when at sea.

Modern chart "rose" shows the relationship between magnetic and true north.



Activities

1. Learn to read and use marine charts.
2. Visit the bridge on a commercial or fishing boat and see how navigation equipment works.
3. Fix your position at various points on a field trip, etc.
4. Make a compass, and show how it is affected by lines of force.
5. Learn to plot courses on a chart.

References

1. Seas, Maps, and Men: An Atlas History of Man's Exploration of the Oceans, by P. Hamlyn. 1962. Geographical Projects Limited. London, England. \$3.97.
2. Piloting, Seamanship and Small Boat Handling, by Charles F. Chapman. 1971. Hearst Corporation, New York, N.Y.
3. The Sea Around Us - "Special Edition for Young Readers," by Rachel Carson. 1968. Golden Press. New York, N.Y.
4. Chartwork for Fishermen and Boat Operators, by G.A. Motte. 1973. URI Marine Advisory Service, Narragansett, R.I. \$3.00.
5. Navigation for Fishermen and Boat Operators, by G.A. Motte. 1973. URI Marine Advisory Service, Narragansett, R.I. \$3.50.

Nautical charts may be purchased at most large marine supply firms. Nautical catalogues and charts can be ordered directly from: U.S. Department of Commerce, Distribution Division C44, National Ocean Survey, Washington, D.C. 20235. There is no charge for the catalogues.

Films

1. "To Help Man Find His Way," Modern Talking Pictures. 1212 Avenue of Americas. New York, N.Y. 10036. 28 min. color .
2. "Modern Geodetic Survey," Navy Film No. MN10203. Write to Assistant for Public Affairs of your local Naval District Office. 16 mm., 22 min. color .
3. "The Shape of the Earth," McGraw-Hill text films, 330 West 42nd Street, New York, N.Y. 10036. 16 mm., 28 min. color.

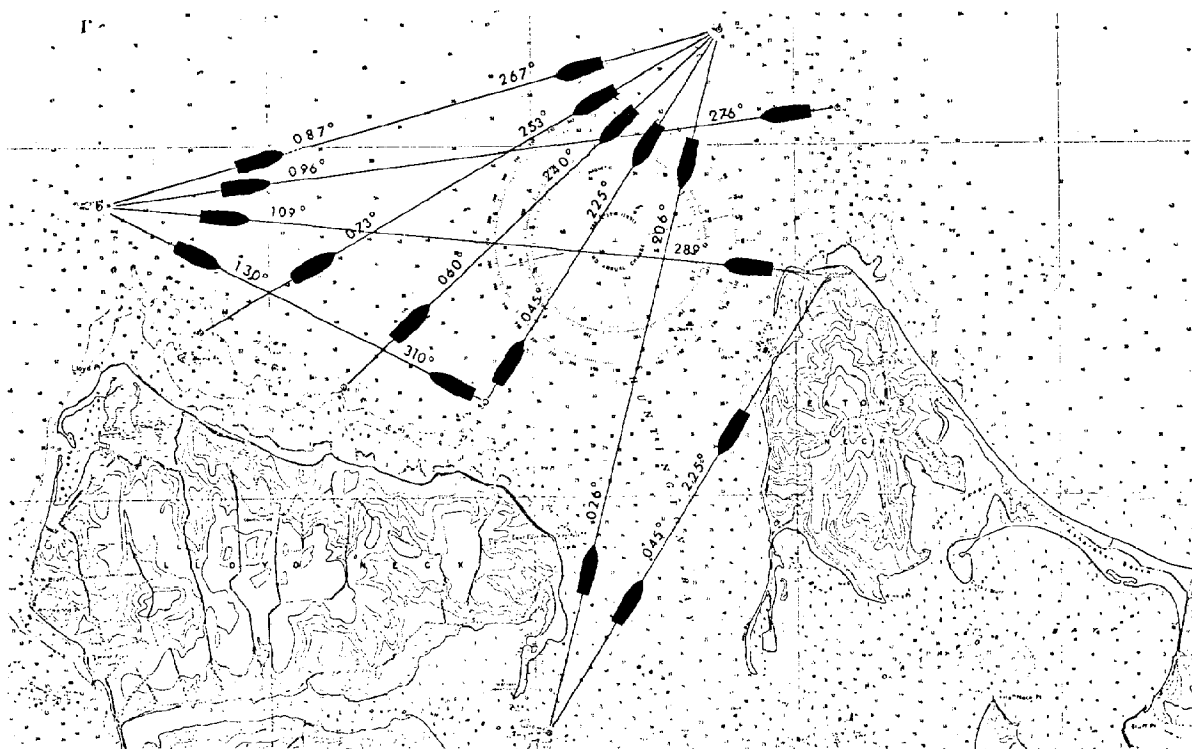


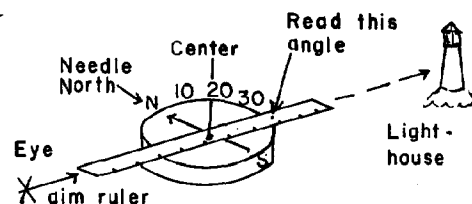
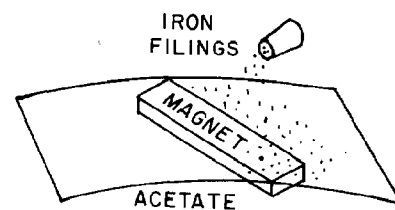
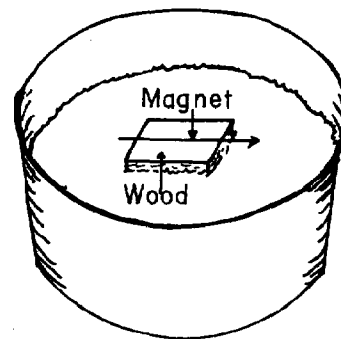
Chart segment showing magnetic headings from buoy to buoy.

Navigation

FOR THE STUDENT

Activities

1. Obtain a marine chart for your area, learn how to read the chart and its symbols.
2. Make an ancient compass. Obtain a bar magnet or rub a thin nail against a strong magnet several times. Place your magnet on a small piece of wood so it floats freely in a bowl of water. Compare the direction of the nail to the direction of the needle on a hand compass.
3. Make a map of a force field. Obtain a magnet, place it on a table and cover it with a thin piece of plastic, acetate or paper. Sprinkle iron filings around the magnet like pepper; keep at it until you get a pattern. What do these lines of force have to do with how your compass works?
4. "Fix" your position by triangulation using a compass. Place an ordinary hand compass on a flat surface (not near metal). Turn your compass so needle and card point North. Lay a straight stick or ruler across the center of the compass. Now without moving the compass aim the ruler at a lighthouse, buoy, radio tower or other landmark. Write down the angle under the ruler on the side closest to the lighthouse. Don't move the compass. Aim the ruler at two new objects, record the angles. Now go to a chart of the area, find a compass rose and make a parallel line to the correct angle on the compass rose through the lighthouse and other object you took a fix on. The area point where all three lines come together is where you are. The smaller the point where the lines come together the more accurate your methods.
5. Visit a large commercial or fishing boat and see all the navigation equipment and how it works.



References

1. Piloting, Seamanship and Small Boat Handling, by Charles F. Chapman. 1972. Hearst Publications, New York, N.Y. \$11.50.

ARTS AND THE SEA

FOR THE TEACHER

Major Points

1. Music in the form of the chanty played an important role in working on sailing ships.
2. Ballads have long been used as a means of celebrating epic events.
3. Water and the sea have influenced many famous composers, artists, poets and novelists.

Some Novelists

Kenneth Roberts, Jack London, Herman Melville, Ernest Hemmingway, C.S. Forester, Henry David Thoreau, Edward Rowe Snow.

Some Poets

Henry Wadsworth Longfellow, John Greenleaf Whittier, Oliver Wendell Holmes, John Masfield, Samuel Taylor Coleridge, Walt Whitman, Rudyard Kipling.

Some Artists

Winslow Homer, C.C. Evers, Andrew Wyeth, John Sisson, Paul Stetson Loring, Jack Gray, John Singleton Copley, Gilbert Stuart, Fitzhugh Lane.

Some Composers

Debussy, Mendelssohn.

4. Ship models, figureheads, scrimshaw and macramé were among the arts of the men who built and sailed wooden ships.

Activities

1. Visit historic seaports, marine museums, art galleries and museums of science and industry.
2. Have the class read books (history or historical fiction) about American ships and sailors between 1750 and 1900. There is plenty of material for all age levels and interests.
3. Make collages of flotsam and jetsam from the beach.
4. Make a knot board displaying different types of knots and their uses.
5. If you live in a shore community, study its relationship to the sea over the last 100 years. If you do not live near the ocean, pick a historic seaport to study.

References

Books:

1. The History of American Sailing Ships, by Howard I. Chapelle. 1935. W.W. Norton, New York, N.Y. \$25.00.

2. The European Discovery of America: The Northern Voyages AD 500 -1600, by Samuel Eliot Morison. Oxford University Press, Fairlawn, N.J. \$15.00.
3. Chanteying Aboard American Ships, by Frederick Pease Harlow. 1962. Barre Gazette, Barre, Me. (paper - Dover.)
4. Shanties and Sailors Songs, by Stan Hugill. 1969. F.A. Praeger, New York, N.Y. \$7.50.
5. Songs the Whalemens Sang, by Gale Huntington. 1964. (paper, 1968, Dover, \$3.00.)
6. American Sea Songs and Chanties, by Frank Shay. 1888. Reprinted W.W. Norton, New York, N.Y., 1948. \$10.00.
7. A History of American Marine Painting, by John Wilmerding. International Marine Publishing Co., 21 Elm St., Camden, Me. 04843. 302 p. \$25.00.
8. Man and the Sea, by Bernard L. Gordon. 1971. The Natural History Press, Garden City, N.Y. \$9.95.
9. Piloting, Seamanship and Small Boat Handling, by Charles F. Chapman. 1971. Motor Boating, New York, N.Y. 695 p. \$11.50.
10. Great Atlantic Adventures, by Edward Rowe Snow. 1970. Dodd, Mead & Co., New York, N.Y. \$5.95.
11. The Flowering of New England, by Van Wyck Brooks, paper, E.P. Dutton, New York, N.Y. \$2.45.
12. Great Sea Poetry, by Rudyard Kipling and others. 1969. Compass Publications, Inc., Arlington, Va. 22209

Filmstrip:

1. "Songs of the Sea." Society for Visual Education. Hand-drawn color filmstrip with 33-1/3RPM record of four chanties and their history (recommended for fourth grade and up).

Films:

NOTE: The films on this list are available from state libraries and other sources at reasonable rentals.

1. "Colonial Shipbuilding and Sea Trade" (A 10). 15-minute, color, sound. The effects of the economy and geography on 17th Century New England, and the reasons that New England became a shipping area are shown, as well as the effects of the English Navigation Acts on the colonial economy. Filmed at Jamestown, it shows colonial ships, tools and costumes. \$5.00 (insure for \$75.00). A limited number of copies is available from Photography/Audiovisual Division, Marine Historical Assn., Inc. Mystic Seaport, Mystic, Conn. 06355.

The following two films are not available for rental from Mystic Seaport. They are distributed nationally by: Creativision, Inc., 295 West 4th Street, New York, N.Y. 10014. Please write directly to them for rental information.

2. "Mystic Seaport" 15-minute, color, sound. Recently produced film, showing highlights of Mystic Seaport. Excellent preview for groups planning to tour Mystic Seaport or even a good substitute for those unable to come in person. \$20.00.
3. "New England Sea Community" 18-minute, color, sound. Life in 19th century sea-coast community is seen through the eyes of a 13-year-old boy. About to leave school, he is trying to decide what he will do in life. In addition to showing activities in the homes and village shops, an exciting sequence from the 1921 motion picture "Down to the Sea in Ships" shows crew of the whaleship, Charles W. Morgan, taking a whale. Produced by Indiana University, it was filmed at Mystic Seaport. \$20.00.

Arts of the Sea

FOR THE STUDENT

From time immemorial man has been fascinated by the sea. Both those who make a living on the sea and those who only view it from the shore have been influenced by it. Our music, literature and art are filled with examples. The men who manned the ships used music to help them with their work and to entertain each other. Their art often decorated their ships, using whatever materials were on hand--bits of rope, wood or the tooth of a whale. Their exploits were recorded in history and fiction. The shipowners frequently hired artists to paint pictures of their ships. Composers and poets tried to capture the sea in poetry and music.

Activities

1. Read a sea adventure by one of the following authors:

Kenneth Roberts
Herman Melville
Ernest Hemmingway
Jack London

Edward Rowe Snow
Jules Verne
Thor Heyerdahl
Peter Fruchen

2. Look for examples of American marine painting in an art museum, in the print collection, in the library or in a book on American artists.
3. Try your hand at macrame, which is in fashion today. Good instruction books are available in most bookstores. In the days of sailing ships the bos'n had to keep the new rope locked up so the sailors wouldn't steal it.

POLLUTION

FOR THE TEACHER

Major Points

1. Pollution and resources.
2. Types of oceanic pollution: water, air, dumping, thermal, filling (development), pesticides, heavy metals, etc.
3. Importance of shorelands, especially wetlands.
4. What can be done by students/lay people.
5. Scope of oceanic pollution (not just in harbors, etc.).

Activities

1. Use diagrams on student activity sheet for overlay projection. Enlarge them for display.
2. Visit state capital and/or get a legislator to speak on relevant legislation.
3. Get appropriate legislative committee members to speak.
4. Visit a sewage or water treatment plant.
5. Get speakers on thermal pollution - power company representatives, marine biologists, and conservationists.
6. Study oil spill reports through case histories.
7. Have experts discuss methods of preventing oil spills, keeping them from spreading, etc.
8. Call on local Audubon Society for marine pollution materials (slides, pamphlets, etc.).
9. Go on a marsh walk.
10. Go on a harbor or shore walk. Who are the polluters? Make an inventory map.
11. Get a representative of a conservation agency to go with the class on a harbor tour via pleasure or charter boat.
12. Plan a group clean-up of an area.
13. Have a "Dirty Picture" photo contest. Show pollution scenes along shore. Post entries in school, city hall or a local store.
14. Raise money for ecological purposes by selling (environmental) pollution posters.
15. Make up a collage or slide show on shore pollution in a local or nearby area.
16. Test water for various parameters or just visually compare water collected from several areas.

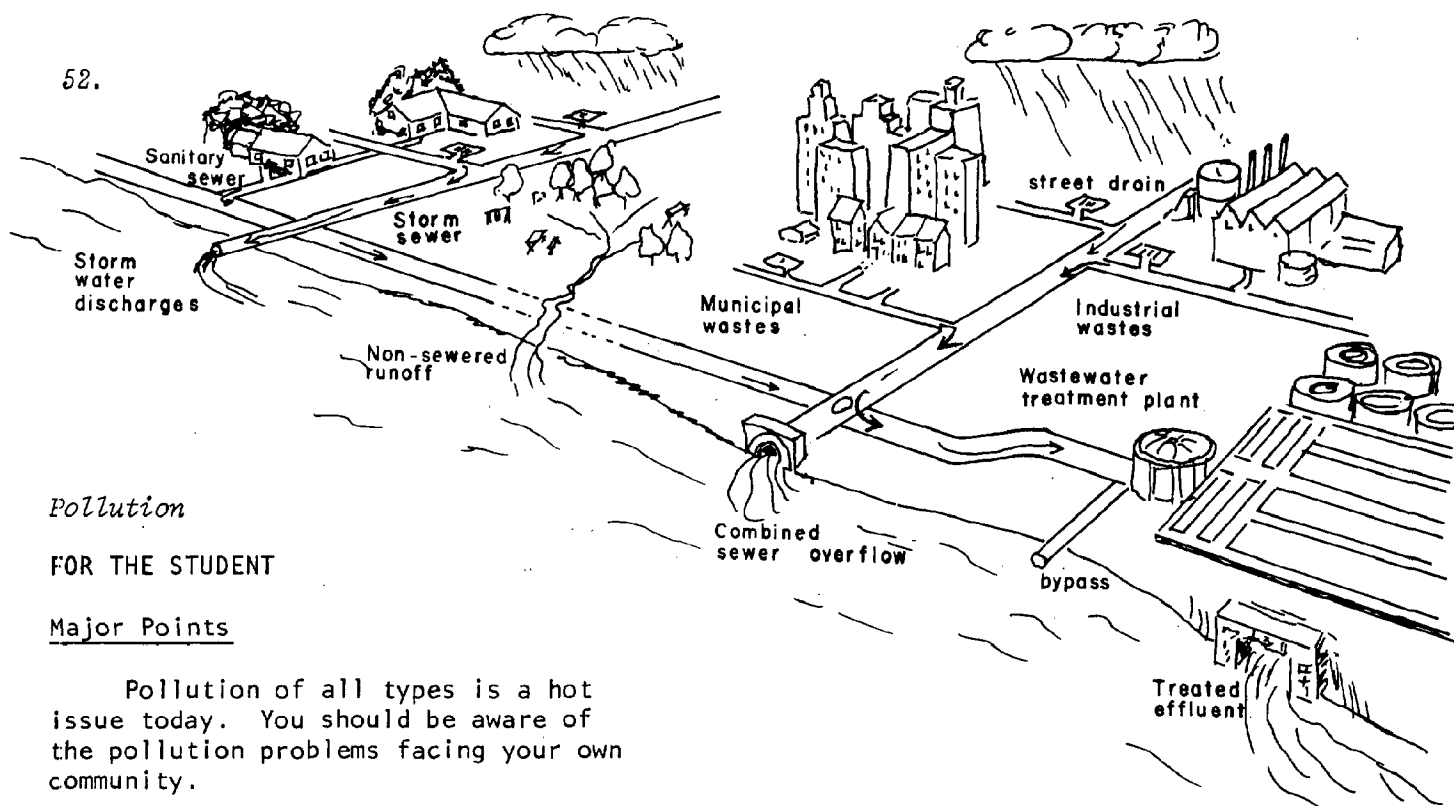
17. Report on case histories of pollution in class.
18. Bring in some "ripe" sea mud to class. Smell, discuss the processes of decay/decomposition. Do they mean pollution is present?
19. Arrange to hear New England Aquarium illustrated pollution talk.

References:

1. For coastal/bay studies, write Army Corps of Engineers Regional Office, Trapelo Rd., Waltham, Mass.
2. Contact State Dept. of Natural Resources, Marine Division.
3. Sierra Club, Boston Office, 373 Huron St., Cambridge, Mass., is very interested in oceanic pollution and has put considerable time on Boston Harbor studies.
4. Environmental Pollution, Prentice Hall, Englewood Cliffs, N.J., is a source of planned activities.
5. Contact state development agencies for materials (also state port authorities if they exist).
6. League of Women Voters in your area may have shore or wetlands committees.
7. Save Our Shores (SOS), P.O. Box 103, North Quincy, Mass. 02171 has a free slide show on Boston Harbor.
8. Secure film listings from these sources;
 - a. U.S. Dept. of Interior - FWOA, John F. Kennedy Building, Boston, Mass. 02203.
 - b. U.S. Dept. of Interior, Regional Office - Bureau of Sport Fisheries and Wildlife, U.S. Post Office, Court House Building, Boston, Mass. 02109.
 - c. Environmental Protection Agency, John F. Kennedy Building, Boston, Mass. 02203.
9. For a film, "Crisis in the Estuary," (Color, 15 min.), write to Milner-Fenwick Inc., 3800 Liberty Heights Ave., Baltimore, Md. 21215, (\$10 rental).
10. Read The Life and Death of the Salt Marsh, by John and Mildred Teal. 1969. Little Brown and Company, \$7.95.
11. New England Aquarium has materials on pollution. Central Wharf, Boston, Mass. 02210.
12. Write American Littoral Society, Sandy Hook, N.J., for material on ocean dumping (crisis area is New York Harbor).
13. Massachusetts Audubon Society, Drumlin Farms, So. Lincoln, Mass., is a good source.

14. The Environmental Protection Agency provides a number of publications and wall posters free: "A Primer on Waste Water Treatment," "What You Can Do About Water Pollution," "Toward a New Environmental Ethic." Write to them at: Environmental Protection Agency, John F. Kennedy Building, Boston, Mass. 02203.
15. Very nice wall charts with valuable information on air pollution (\$2.00 each) and water pollution (\$2.50) are available from: Roy G. Scarfo, Inc., P.O. Box 217, Thorndale, Pa. 19372.
16. Wall chart "How Man Pollutes His World" was printed on the back of the "World Map" in the December 1970 issue of the National Geographic. Additional copies may be obtained for \$2.15 on paper and \$3.30 on plastic from: The National Geographic Society, Washington, D.C. 20036.

52.



Pollution

FOR THE STUDENT

Major Points

Pollution of all types is a hot issue today. You should be aware of the pollution problems facing your own community.

What can you do to protect the world of water? Investigate your drinking water. Find out where the water you drink originates and what processes it goes through before it reaches your faucet. Learn who else might have used the water before it reached you.

Stop to think -- about where the water is going, about how much water is being wasted. Turn off the faucet when you brush your teeth, do not fill the bathtub to the rim when you bathe, take "quickie" showers, put a brick in the tank of your toilet, use your washing machine, garbage disposal and dishwasher only when you have full loads. Conserve water.

Use detergents that are low in phosphates. They should also be biodegradable, and should not contain other harmful chemicals. On a larger scale, work for legislation that will protect or clean up waterways and wetlands.

Report pollution; contact local, state and federal authorities. Take photographs to document problems. Try to include something in the photograph that definitely identifies the source of the pollution and location of the polluter, whatever it is.

Man at the end of the food chain must be concerned about the pollution of our wetlands.

In The Marsh, William Niering defines the marsh:

A treeless form of wetland, often developing in shallow ponds or depressions, river margins, tidal areas, and estuaries. Marshes may contain either salt or fresh water. Prominent among the vegetation of marshes are grasses and sedges.

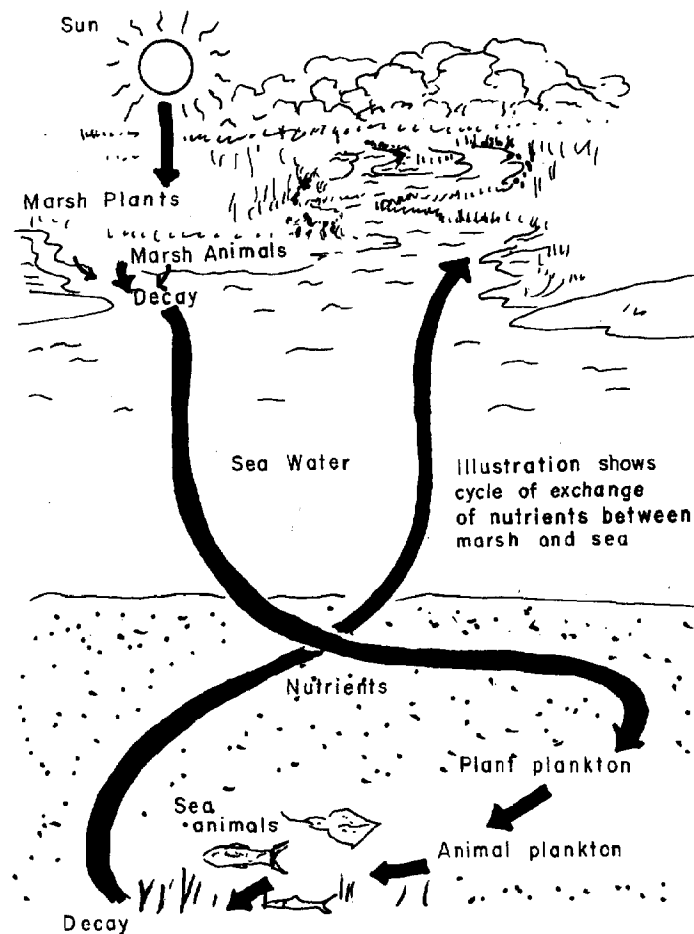
The salt marshes of the Atlantic coast are nurseries for the sea. Two-thirds of the commercial catch of fish and shellfish landed on the east coast of the U.S. comes from species spending part of their life cycle in marsh estuaries. In a complex food web, photosynthesis of algae and the dominant Spartina (grasses) ultimately leads to detritus

that nourishes planktonic forms of life. The plankton nourishes fishes and invertebrates, which in turn provide a food source to small mammals and birds. Man, at the top of this food chain, is an end consumer.

Man is polluting his valuable wetlands with thermal, sewage, trash, garbage, heavy metal and pesticide pollution.

An acre of healthy marsh is ten times more productive than a wheat field of comparable size. Migrating birds depend on the marsh for survival. Not an occasional marsh, but the entire chain stretching along our coastline must be preserved!

Read The Life and Death of the Salt Marsh by John and Mildred Teal and The Marsh by William Niering.



MARSH LIFE CYCLE

COASTAL ZONE USES

FOR THE TEACHER

Major Points

1. Four primary interests--recreational, industrial, educational and commercial--are competing for the very small acreage of marine zone environment that still remains undeveloped. Seventy percent of the U.S. population is in coastal states and this population is primarily along the shore.
2. Presently even the offshore zone is rapidly becoming overcrowded with many activities overlapping and obstructing each other.
3. Some "new" resources are still available in the North Atlantic including minerals such as sand and oil and unexploited species of fish, shellfish and crustaceans.

Activities

1. Plan a model development of an estuarian area--preserving its basic biology while still making it available to industrial, recreational and commercial use.
2. Prepare an environmental impact statement for each of the above interests.
3. Contact the state clearinghouse that files environmental impact statements and request the statement filed by a local interest planning a marine zone project. (Required by Section 102 (2) (c) of the National Environmental Protection Act.)
4. Have a city planner or a landscape architect discuss land use planning with your class.

References

1. The Frail Ocean, by Wesley Marx. 1967. Ballantine Books, Inc., New York, N.Y.
2. Population, Resources, Environment, by Paul R. and Ann H. Ehrlich. 1970. W. H. Freeman and Company, San Francisco, Calif., 383 p. \$8.95.
3. Design With Nature, by Ian L. McHarg. 1969. The Natural History Press, Garden City, N.Y. \$4.00 (paper).

Coastal Zone Uses

FOR THE STUDENT

With the growth of our population, there is a growing demand for renewable resources, such as food, lumber and other items which can be grown or naturally recycled, and nonrenewable resources, such as fossil fuels which are consumed and cannot be replaced or recycled. We live in a consuming society. We are just beginning to think in terms of recycling many metals and just beginning to worry about what will happen to plastics which as yet are not recycled either by nature through biological decay or by man through remanufacture.

Water is a resource unique to planet Earth. In the past, we have relied on nature to recycle water through the "hydrologic cycle." Nature may not be able to keep up with man's demands. That is, man pumps fresh water out of the ground faster than it can be replaced by natural precipitation, and he dumps sewage back into lakes, streams and the oceans faster than nature can recycle it without upsetting the natural balance.

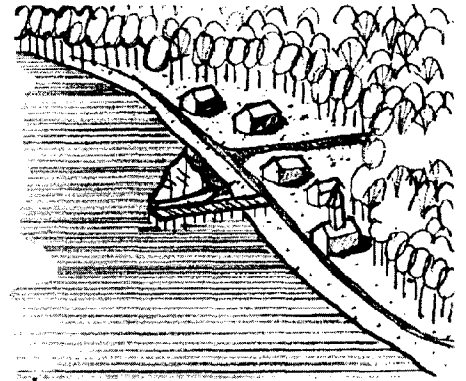
Space on the surface of this planet is also limited. In the inner city, one way to recycle space is by tearing down small buildings and replacing them with taller ones. Most of the major cities of the world are located around harbors; 70 percent of the people in the United States live in coastal states. In many of our more densely populated states (which are coastal states), less than 10 percent of the shoreline is available for use by the public.

An Activity

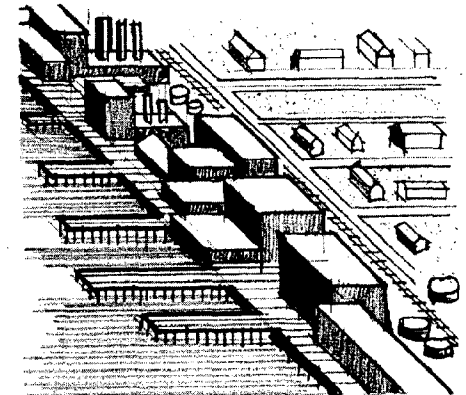
Make or get a map of your community. Use it to describe how land is presently being used. Use different colors to depict woods, parks, residential, business and industrial areas, polluted waters, etc. Make a new improved plan. Remember that you have to provide for the community's need for education, recreation, jobs, housing, services, businesses, utilities and transportation. Remember that low-lying areas are easily flooded during storms, that marshes serve as nurseries for many fish of commercial and recreational value and most importantly that man must somehow live in harmony with nature.

A Reference

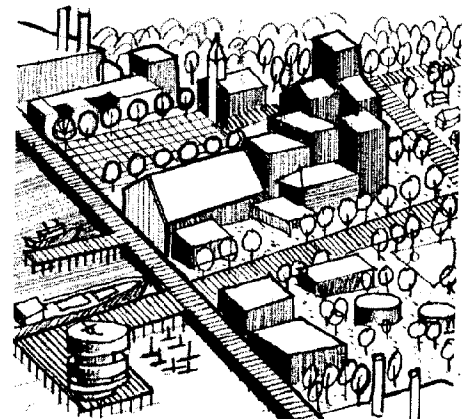
The Frail Ocean, by Wesley Marx. 1967. Ballantine Books, Inc., New York, N.Y. 95¢.



Cities began at the water's edge



As cities grew a barrier developed which separated man from the water's edge.



Lift all barriers: everything can live at the water's edge.

MARINE CAREERS

FOR THE TEACHER

Major Points

1. There are almost as many careers related to the sea as there are careers on land. Many "sea people" work on land most of the time.
2. Increasing exploitation of the seas promises a growing need for personnel in marine related careers (despite present saturation of the market by ocean scientists). Opportunities are increasing in new fields such as marine law, aquaculture (fish farming), education, and communications.
3. Because of the diversity of marine related jobs available, education requirements vary. To become an oceanographer (specializing in biological, geological, physical, or chemical oceanography) or an ocean engineer you must spend at least eight years studying after completing high school. The social scientists, such as marine resource economists, marine lawyers, and community planners, must also study for eight years after completing high school. Those who would like to operate their own marine business (such as a marina, a ship chandlery, or a fish processing plant) will need experience in business management and will probably need at least four years of college experience. The scientific photographer and technical illustrator will need communications skills. The marine extension worker must have a broad educational background, possibly including teaching, marine technology and research, and public relations. Technicians, who are needed to operate and maintain equipment, may require two to four years of education beyond high school. For some jobs at sea such as sailmaking, fishing, and being a boat captain, education is generally obtained through apprenticeship and/or experience.

Activities

1. Visit waterfronts, government offices, universities, and businesses involved in working with the sea.
2. Invite speakers from these marine related trades, businesses and professions.
3. Have the class try to think of careers on land that couldn't have corresponding careers in the sea.
4. Skim the yellow pages for listings of marine related businesses.

References

1. Exploring the World of Oceanography, by Dorothy Telfer. 1968. Children's Press, Chicago.

2. How and Why Wonder Book of Oceanography, by Robert Scharff. 1972. Grosset and Dunlap, New York.
3. Sea Careers, by D.X. Fenten. 1970. Lippincott. Philadelphia.

Films:

1. "The Marine Biologist," (14 min.) Encyclopedia Britannica Films, Inc., 425 North Michigan Avenue, Chicago.
2. "Scientist in the Sea," U.S. Navy, Assistant for Public Affairs for your Naval District (when writing refer to MN-10320).

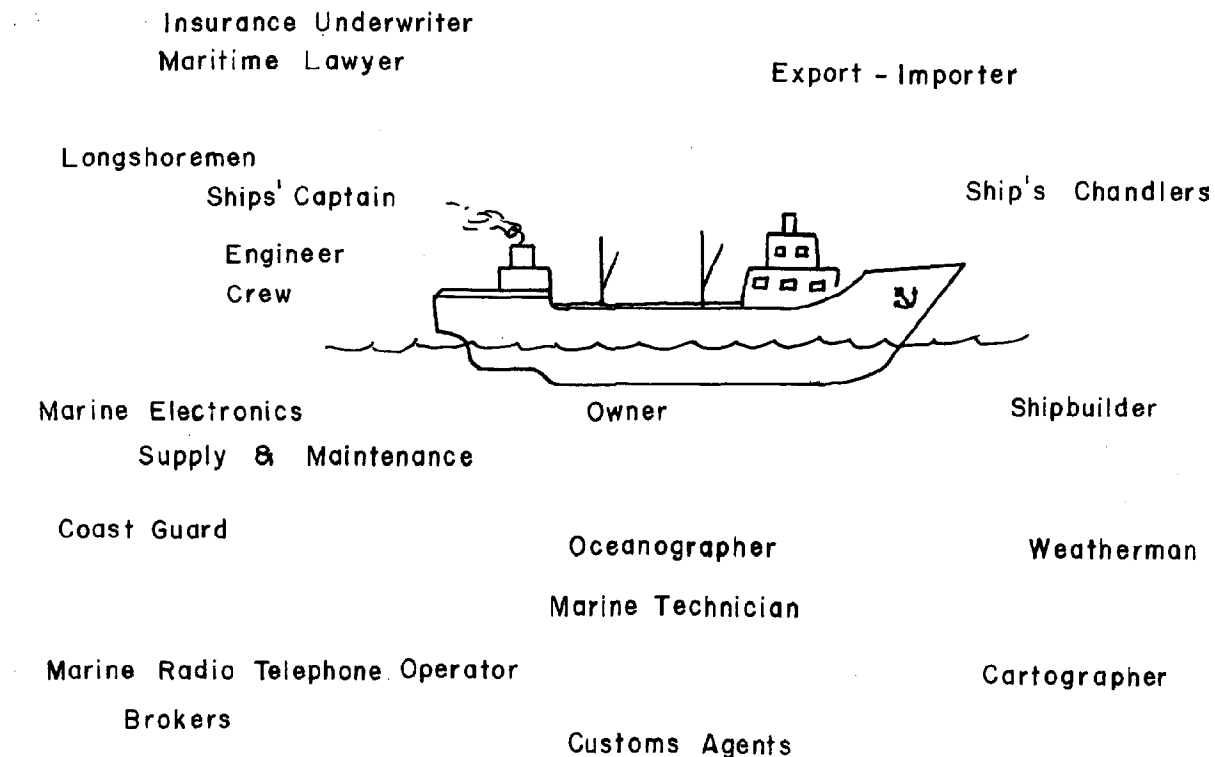
Marine Careers

FOR THE STUDENT

Almost every career on land has a corresponding marine career. These careers run full range from unskilled laborers through skilled laborers and tradesmen to highly trained scientists and engineers. Men of the sea may have little formal education but much experience in the "school of life." Of the many who are challenged to venture upon the sea itself, many are cast back upon the land, unable to withstand the vigors of life on the sea, while those who do stay seem to become a little different than other men.

Only a small number of those who earn their living from the sea actually work on it. Most work at the edge of the sea, conducting all the business that depends on the sea or that is necessary to support seaborne activities. And millions of people come to the edge of the sea for recreation. They in turn create more jobs.

Make the silhouettes of a sailing yacht and a fishing boat. Then make a list of all the people whose jobs relate to both of these types of vessels. Some of these people support each other as well as the vessel and its owners. Try to think of all the interrelationships. Have a contest with your classmates to see who can come up with the most complete list.



FREIGHTER WITH ITS SUPPORTING OCCUPATIONS

**COASTAL ZONE
INFORMATION CENTER**

